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# EARTH RESOURCES TECHNOLOGY SATELLITE FINAL REPORT

## 7. QUALITY PROGRAM PLAN

PREPARED FOR

GODDARD SPACE FLIGHT CENTER  
NATIONAL AERONAUTICS  
AND SPACE ADMINISTRATION

UNDER CONTRACT NAS5-11260



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EARTH RESOURCES TECHNOLOGY SATELLITE

FINAL REPORT

Volume 7. Quality Program Plan

April 17, 1970

prepared for

National Aeronautics and Space Administration  
Goddard Space Flight Center

Contract NAS5-11260

item 5a

TRW Systems Group  
One Space Park • Redondo Beach  
Los Angeles County  
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## ROAD MAP

### REVISIONS AND ADDITIONS TO FEBRUARY SUBMITTAL

Subsequent to the 90-day proposal submittal this volume has been expanded or changed to include system or GDHS inputs. To facilitate NASA review, additional or changed information appears only on yellow pages. The changes on each yellow page, identified by shading in the entire area of change, are on the pages listed below. Yellow colored pages with no shaded portions contain all new inputs.

<u>Page</u>	<u>Comment</u>
Cover Page	New cover page
iii	Page changes
iv	Page changes
v	Page changes
1-2	Added GDHS requirement
1-3	Clerical error correction
1-5	Clerical error correction
2-1	Added software requirement
2-5 through 2-7	Added GDHS requirement
2-8	Clerical error correction
2-10	Added GDHS requirements
2 through 2-31	Added software requirements
5-2 through 5-5	Added GDHS requirements
6-1	Added software requirement
6-4	Added software requirement
6-6	Added software requirement
7-2 through 7-4	added GDHS requirements
7-5	Added software requirements
7-9 and 7-10	Added software requirements
7-17 and 7-18	added GDHS requirements
7-20	Added GDHS requirements
7-21 and 7-22	Software requirements incorporated
7-23 through 7-25	Added software requirements
8-4	Incorporated software requirements
8-8	Added GDHS requirements
9-2 through 9-4	Added GDHS requirements
10-1	Incorporated software requirements
11-2	Incorporated software requirements
A-27 through A-57	Added exhibits for GDHS and software requirements

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## CHAPTER 1: INTRODUCTION

### 1B100 General

This quality program plan sets forth the quality program requirements for the ERTS project and includes both the observatory and ground data handling systems. It defines the requirements for the effective implementation of a quality program to ensure that quality criteria and its requirements are recognized, definitized, and performed satisfactorily.

### 1B101 Relation to Other Contract Requirements

The format of this plan parallels the headings of Specification NHB 5300.4 (1B), "Quality Program Provisions for Aeronautical and Space System Contractors" and detailed requirements contained in other parts of the contract. This plan, in conjunction with the procedures referenced herein, will be the governing quality specification for the project. Where overlaps exist between plans due to overlaps in specifications, references will be made to the appropriate plans. The Quality Program Plan is organized to support the Reliability and Test Monitoring and Control Plans.

### 1B102 Actions and Prerogatives of the Government

The activities of the quality assurance system are subject to continuous surveillance by NASA and Defense Contractors Administration Services (DCAS) quality assurance representatives. Specific mandatory inspection points, as established by contract, will be documented in a quality assurance project item requirement procedure (QAPIR) upon receipt of detailed requirements from the government agencies. Documents, records, equipment, facilities, and assistance are provided to the government representatives for performance of their duties.

### 1B103 Quality Program Documents

Quality assurance system policy (QASP) 1.2 and systems quality instruction (SQI) 1.2.1 entitled "Quality Assurance System of Documents," describe the policy and procedural documents to be utilized as the company standard for controlling product quality. A list of TRW Systems Group quality policies and procedures to be applied to the ERTS project is specified in Attachment 1 to systems quality instruction 1.1.1 entitled

"Project Quality Requirements, Project ERTS" (see Exhibit 1-1). Additions, deletions, or modifications to the TRW quality assurance system are not planned for the ERTS project.

The TRW quality assurance manual meets the basic requirements of NHB 5300.4 (1B). Figure 1-1 identifies the relationship between this specification and the project applicable TRW quality assurance manual procedures. Specific quality project requirements are issued under separate quality instructions identified with the ERTS project. For example, quality assurance project item requirements (QAPIR's) will be generated at appropriate phases in the schedule.

- Exhibit 1-1, "Attachment to Systems Quality Instruction (SQI) 1.1.1, Project Quality Requirements" (Unreleased)
- Exhibit 1-2, "Product Assurance Requirements for ERTS Suppliers (PAR 700-52)"
- Exhibit 1-3, "Product Assurance Requirements for ERTS Subcontractors (PAR 700-53)"
- Exhibit 1-4, "Project ERTS Subcontractors for GDHS Equipment (PAR 700-55)"
- "Quality Assurance Project Item Requirement (QAPIR) on Government Mandatory Inspection Requirements" (to be prepared upon request from NASA/GSFC and DCAS)

In conjunction with this quality plan, the applicable quality assurance system policies and systems quality instructions are Type I controlling the implementing quality documents for the ERTS project quality functions which are subject to NASA approval.

Project amendments to systems quality instructions (SQI's), quality assurance project item requirements (QAPIR's), quality instructions (QI's), project quality instructions (PQI's), quality assurance forms facsimile manual (QAFFM), and quality operating instructions (QOI's) are Type II documents used to supplement Type I documentation into detailed departmental, project, and operating procedures. These documents are considered internal management documents. These Type II documents are modified as the need arises and upon release will be made available for review by the contracting agency.

Table 1-1 tabulates a listing of quality program documents referenced in Appendix A of NHB 5300.4 (1B) and quality documents listed in the contractual performance assurance data requirements list for ERTS.

[illegible]

Figure 1-1

RELATIONSHIP BETWEEN  
NHB 5300.4 (1B) AND QUALITY  
ASSURANCE MANUAL PROCEDURES

NHB 5300.4 (18)  
QUALITY PROGRAM PROVISIONS  
FOR AERONAUTICAL AND SPACE  
SYSTEM CONTRACTORS

1-5

Table 1-1. Quality Program Documents and Data Requirements List

Reference	Document/Data	Development and Control	Retain/Submit Schedule
1B202-1	Training documents	As applicable	Retain
1B202-4	Training and certification records	As applicable	Retain
1B203	Quality information	Quality systems department	Retain
1B204/DRL	Quality status report	Project quality office	Submit
1B205-3/DRL	Quality program audit reports	Quality assurance directors office / project quality office	Submit
1B206/DRL	Quality program plan	Project quality office	Submit
1B206-2b	Policies and procedures	Quality directors office	Submit, as required
1B300	Technical documents	As applicable	Submit, as required
1B300-2	Document review	Division project quality management	Retain
1B302	Change control system document	Configuration management	Retain
1B404	Identification list	Configuration management	Submit, as required
1B501-1	Quality records	Procurement quality	Retain
1B 501-2/DRL	Pre-award survey results	Procurement quality	Submit, as required
DRL	Supplier listings	Quality assurance staff	Submit
1B502-1	Procurement documents	Procurement quality	Retain
DRL	Subcontractor quality plans	Project quality office	Submit, as required
1B506	Receiving records	Receiving inspection	Retain
1B508-1	Post award survey schedules	Procurement quality	Retain
1B508-3	Post award survey results	Procurement quality	Retain
1B600	Fabrication documents	Production control	Retain
1B603-2	Process control procedures	Division manufacturing, engineering, and materials and processing	Retain
1B603-3	Equipment certification records	Division manufacturing	Retain
1B604	Workmanship standards	Design engineering	Retain
1B701	Inspection and test planning	Quality assurance planning	Retain
1B702	Test specifications	Design engineering	Retain
1B703	Inspection and test procedures	Test and project quality engineers	Retain
1B704/DRL	End-item inspection and test specification and procedures	Integration test engineering and project quality office	Retain
1B705-7/DRL	End-item inspection and test report/observatory, GDHS, DCS accept test reports	Applicable test engineering and project quality office	Submit, as required
1B706-1/DRL	Inspection and test records and data	Quality assurance records center	Submit, as required
1B706-2/DRL	Equipment records	Quality assurance records center	Submit, as required
1B801/DRL	Nonconformance documentation	Quality assurance records center	Submit
1B805	Written requests for NASA contracting officer approval	Performance assurance	Submit, as required
1B900	Procedures for measurement processes	Operations support (metrology)	Retain
1B902-3	Results of evaluations	Operations support (metrology)	Retain
1B905-7	Calibration records	Operations support (metrology)	Retain
1B1000	Stamp control procedures	Quality assurance staff	Retain
1B1100-1	Handling instructions	Materiel and division manufacturing	Retain
1B1100-2	Storage procedures	Materiel and integration stores	Retain
1B1101-3	Packing procedures and instructions	Materials handling and packaging engineers	Retain
1B1102-2	Documentation package	Integration planning and logistics and project quality office	Submit, as required
1B1300-4	Government property records	Custodial organization	Retain

The ERTS project quality manager will be responsible for assuming the availability of acceptable documentation in accordance with the specified schedule.

## CHAPTER 2: QUALITY PROGRAM MANAGEMENT AND PLANNING

### 1B200 General

Quality assurance program planning at TRW begins with participation by quality assurance personnel in the review and generation of inputs to the initial program proposal. Quality assurance controls are established for each type and model of hardware in accordance with Tables 2-1 through 2-3.

Quality Assurance for software is contained in Table 2-6. After receipt of the contract, special contract requirements are defined, and manpower and costs are allocated for the various quality assurance tasks. These tasks encompass procurement, engineering design, development, fabrication, processing, assembly, inspection, test, checkout, packaging, shipping, storage, maintenance, field use, flight preparation, flight operations, and ground data handling. Objective evidence of quality conformance including records of inspection and test results will be readily available to the contracting agency and their designated government representatives.

### 1B201 Organization

This section describes the TRW quality assurance organization and policies which will govern the quality tasks described throughout this plan.

Quality assurance responsibilities for the ERTS project, defined throughout this plan, have been established in accordance with quality assurance systems policy (QASP) 1.0, "Quality Assurance Policy and Organization". Quality assurance participates through all phases of the project from design to launch and postlaunch operations, including operation of the ground data handling system. The quality program is organized to provide prompt detection of problem areas and to facilitate timely and positive corrective action.

The ERTS project office is in the Science and Environmental Systems Operations of Space Vehicles Division, TRW Systems Group. The organizational relationship of the ERTS project quality office is shown in Figure 2-1. The work task description for quality management is shown in Table 2-4.

Table 2-1. Quality Assurance Controls for Each Type of Model

Quality Assurance Manual Section	Quality Assurance Controls	Breadboard Models and Engineering Models Fabricated by Engineering	Engineering Models Fabricated by Manufacturing	Flight, Prototype, and Qualification Hardware
Policy and organization	TRW quality assurance manual	Required	Required	Required
	Quality participation in design reviews and specification reviews	Required - conceptual design review (DR No. 1)	Required - preliminary Design Review (DR No. 2)	Required - critical design review (DR No. 3)
Measuring and test equipment	Measuring and test instrument calibration and maintenance	Required	Required	Required
	Quality assurance approval of calibration procedures	Required	Required	Required
Procurement quality	Verify procurement documents to project quality requirements	Required	Required	Required
	Quality assurance preferred suppliers directory (QAPSD)	Not required	Required for subcontractors and critical suppliers only	Required
	Quality assurance preferred suppliers directory, special process suppliers (QAPSD)	Not required	Required for critical special processes	Required
	PAR 700-52 and 700-53	Not required	Required for subcontractors and critical suppliers only	Required
	Project electronic parts matrix	Not required	Not required	Required
	QA receiving requirements on purchase documents per system instruction 304	Required unless waived by personnel on divisional waiver list	Required	Required
	Receiving inspection	Required unless waived by personnel on divisional waiver list or by PQM/PQE	Required unless waived by PQM	Required
	Chemical and physical tests - raw material, propellant, and special processes	Required for critical items and all raw materials	Required and verified on a sample basis	Required and verified on a sample basis
Inspection and test	Source inspection	Not required	Required for subcontractors and critical suppliers only	Required on subcontracts and additionally where required by project procurement quality requirements
	First-article reporting	Not required	Not required	Prototype model receives total first-article inspection; qualification and flight models receive first-article inspection on all changes

Table 2-1. Quality Assurance Controls for Each Type of Model (Continued)

Quality Assurance Manual Section	Quality Assurance Controls	Breadboard Models and Engineering Models Fabricated by Engineering	Engineering Models Fabricated by Manufacturing	Flight, Prototype, and Qualification Hardware
	Acceptance test procedure review and quality assurance approval	Not required	Required	Required
	Workmanship standards per engineering drawing, process requirements, specifications, fab/inspection process procedures and applicable QOI's	Not required	Required	Required
	Special cleanliness controls in fabrication, assembly, and process areas	Not required	Not required	Required when necessary to assure quality/reliability per applicable specifications
	Finishes and processes	Engineering operation; PR series where critical processes involved	PR series	PR series including personnel certification as applicable
	Manufacturing/quality assurance integrated planning document	Not required	Required; quality assurance must sign off the manufacturing shop paper	Required; quality assurance must sign off the manufacturing shop paper
	Shelf-life age controls	Not required	Required unless waived by project quality manager	Required
	Segregated storage of flight versus ground and engineering model components	Required	Required	Required
	Inspection of tooling	Not required	Required where hardware interchangeability or interfaces are necessary	Required; tools used for hardware acceptance must be certified by quality assurance
	Kitting inspection	Not required	Required; sample basis verification	Required; sample basis verification
	In-process inspection: mechanical, electrical, and process	Support service at request by engineering	As specified on manufacturing shop paper	Required
	Test setup verification	Not required	Required whenever possible	Required; verify to applicable test procedures
	Unit acceptance test surveillance	Not required	Required	Required
	System acceptance test surveillance	Not required	Required	Required
	Test review board	Not required	Not required	Required
	Failure reporting per project procedures	Not required	Required	Required
	Material identification controls	Not required	Required	Required

Table 2-1. Quality Assurance Controls for Each Type of Model (Continued)

Quality Assurance Manual Section	Quality Assurance Controls	Breadboard Models and Engineering Models Fabricated by Engineering	Engineering Models Fabricated by Manufacturing	Flight, Prototype, and Qualification Hardware
	Material and parts substitution	Not required	Not required	Must be authorized by engineering drawing or approved material/part substitution list
	Defect and trend statistics and analysis (performance reporting)	Not required	Required on critical items or multiple builds	Required
Quality assurance records	Unit data package	Not required	Not required	Required
	System level test data package	Not required	Required on formal DVT tests	Required
Traceability verification	Traceability of supplier materials, hardware, and assemblies	Not required	Not required	Required as defined in quality assurance plan
	Traceability of TRW-manufactured items	Not required	Not required	Traceable to applicable MSO/PAL
	Unit identification	Not required	Required	Required
	Unit serialization	Not required	Required in accordance with applicable engineering drawings and configuration management plan	Required in accordance with applicable engineering drawings and configuration management plan
Material review	Formal material review board	Not required	Not required	Required
Corrective action	Corrective action	Not required	Required	Required
Configuration verification	Accepted tag	Not required	Completed tag must be attached to hardware	Completed tag must be attached to hardware
	Quality assurance configuration verification	Not required	Performed whenever possible but not required	Verified to the configuration level recorded on the manufacturing planning documents and full implementation of computerized as-designed versus as-built system
	Drawing and specification	Not required	Approved engineering drawing/specifications	Latest effectivity Configuration Administration and Data Management released documents for respective model

Table 2-2. Quality Assurance Controls for Various Types of Electrical AGE, GDHS, Electronic GSE and Special Test Equipment

Quality Assurance Manual Section	Quality Assurance Controls	GDHS Equipment	Electronic Ground Support Equipment	Special Purpose Test Equipment
Policy and organization	TRW quality assurance manual	Required	Required	Required
	Quality participation in design reviews and specification reviews	Required on critical items	Required	Required
Measuring and test equipment	Measuring and test instrument calibration and maintenance	Required	Required	Required
	Quality assurance approval of calibration procedures	Required	Required	Required
Procurement quality	Verify procurement documents to project quality requirements	Required	Required	Required
	Quality assurance preferred suppliers' directory, special process suppliers (QAPSD)	Required for critical special processes	Required for critical special processes	Required for critical special processes
	Quality assurance preferred suppliers' directory (QAPSD)	Required for subcontracts and critical supplies only	Required for subcontracts and critical suppliers only	Required for subcontracts and critical suppliers only
	Vendor quality requirements: PAR 700-52, 53, and 55	Required for subcontracts and critical supplies only	Required for subcontracts and critical suppliers only	Required for subcontracts and critical suppliers only
	Project electronic parts matrix	Required	Not required	Not required
	Quality assurance receiving requirement on purchase documents per systems quality instruction 304	Required	Required	Required
	Receiving inspection	Required	Required	Required
	Chemical and physical tests - raw material, propellant, and special processes	Required on a sample basis	Required and verified on a sample basis	Required and verified on a sample basis
	Source inspection	Required on subcontracts and critical supplies hardware	Required on subcontracts and critical suppliers hardware	Required on subcontracts and critical supplier hardware
	First-article reporting	Not required	Not required	Not required
Inspection and test	Acceptance test procedure review and quality assurance approval	Required	Required	Required
	Workmanship standards per engineering drawing, process requirement specifications, fab/insp process procedures and applicable quality instructions	Required	Required	Required

Table 2-2. Quality Assurance Controls for Various Types of Electrical AGE, GDHS, Electronic GSE and Special Test Equipment (Continued)

Quality Assurance Manual Section	Quality Assurance Controls	GDHS Equipment	Electronic Ground Support Equipment	Special Purpose Test Equipment
	Special cleanliness controls in fabrication, assembly, and process areas	Not required	Not required	Not required
	Finishes and processes	Design requirements	PR series	PR series where critical processes are involved
	Manufacturing/quality assurance integrated planning document	Required	Required	Required if manufacturing shop paper is used
	Shelf-life age controls	Required	Required	Required unless waived by the project quality manager
	Kitting inspection	Required-sample basis verification	Required - sample basis verification	Not required
	Segregated storage of flight versus ground and engineering model components	Required	Required	Required
	Inspection of tooling	Required	Required where hardware interchangeability or interfaces are necessary	Required; tools used for hardware acceptance must be certified by quality assurance personnel
	In-process inspection - mechanical, electrical, and process	As specified on manufacturing shop papers	As specified on manufacturing shop paper	As specified on manufacturing shop paper
	Test setup verification	Required	Required	Required
	Unit acceptance test surveillance	Required	Required	Not required
	System acceptance test surveillance	Required	Required	Not required
	Test review board (TRB)	Required for integration testing and subsequent operations	Required on system test sets only	Not required
	Failure reporting per project procedures	Required for integration testing and subsequent operations	Not required	Not required
	Material identification controls	Required	Required	Not required
	Material and parts substitution control	Required	Required - authorized by engineering drawing or approved material/parts substitution list	Not required
	Defect and trend statistics and analysis (performance reporting)	Required for maintainability effort	Not required	Not required

Table 2-2. Quality Assurance Controls for Various Types of Electrical AGE, GDHS, Electronic GSE and Special Test Equipment (Continued)

Quality Assurance Manual Section	Quality Assurance Controls	GDHS Equipment	Electronic Ground Support Equipment	Special Purpose Test Equipment
Quality assurance records	Unit data package	Required	Required	Not required
	System level test data package	Required	Required	Not required
Traceability verification	Traceability of supplier material, hardware, and assemblies	Not required	Not required — evidence of prior inspection acceptance	Not required
	Traceability of TRW manufacturing hardware	Not required	Not required — evidence of prior inspection acceptance	Not required
	Unit identification	Required	Required	Required
	Unit serialization	Required	Required	Required
Material review	Formal material review board (MRB)	Required at end-item level	Required at end-item level	Not required
Corrective action	Corrective action	Required	Required	Required
Configuration verification	Accepted tag	Required	Required — completed tag attached to hardware	Required
	Quality assurance configuration verification	Required	Required — verified to the configuration level recorded on the manufacturing planning documents and implementation of computerized as-designed versus as-built system, system test sets only	Not required
	Drawing and specification	In accordance with the project configuration management plan.	In accordance with the project configuration management plan	In accordance with the project configuration management plan

Table 2-3. Quality Assurance Controls for Mechanical Ground Support Equipment (MGSE)

Quality Assurance Manual Section	Quality Assurance Controls	MGSE
Policy and organization	TRW quality assurance manual	Required
	Quality participation in design review and specification reviews	Required
Measuring and test equipment	Measuring and test instrument calibration and maintenance	Required
	Quality assurance approval of calibration procedures	Required
Procurement quality	Verify procurement document to project quality requirements	Required
	Quality assurance preferred suppliers directory (QAPSD)	Required except for packaging, storage boxes, and other than metal handling devices
	Quality assurance preferred suppliers directory special process suppliers (QAPSD)	Required for hardware to TRW specifications
	Vendor quality requirements: PAR 700-52, 53	Required on major critical items only
	Parts matrix	Not required
	Quality assurance receiving requirements on purchase documents per systems instruction 304	Required
	Receiving inspection	Required
	Chemical and physical tests — raw material, propellant, and special processes	Required
	Source inspection	Required on major or critical items
	First-article reporting	Not required
Inspection and test	Acceptance test procedure review and quality assurance approval	Required
	Workmanship standards per engineering drawing, process requirements specifications, Workmanship standards manual, and applicable quality instructions	Required
	Special cleanliness controls in fabrication, assembly, and process areas	Not required except for pneumatic assemblies
	Finishes and processes	PR specification or per drawing, certified personnel on special processes
	Manufacturing/quality assurance integrated planning document	Not required
	Shelf-life age controls	Required
	Segregated storage of flight versus ground and engineering model components	Not applicable
	Inspection of tooling	Required
	Kitting inspection	Not applicable except for pneumatic assemblies
	In-process inspection — mechanical, electrical, and process	As applicable

Table 2-3. Quality Assurance Controls for Mechanical Ground Support Equipment (MGSE) (Continued)

Quality Assurance Manual Section	Quality Assurance Controls	MGSE
	Test setup verification	Required
	Unit acceptance test surveillance	Required
	System acceptance test surveillance	Required
	Test review board (TRB)	Required on major transportation devices and launch support equipment
	Failure reporting per project procedures	Required on proof or leak test failures
	Material identification controls	Required
	Material and parts substitution control	Raw materials may be authorized on form 1912, material substitution
	Defect and trend statistics and analysis (performance reporting)	Required
Quality assurance records	Unit data package	Required on transportation devices and launch support equipment
	System level test data	Not applicable
Traceability verification	Traceability of supplier material, hardware, and assemblies	Not required
	Traceability of TRW-manufactured items	Not required
	Unit identification	Required except for packaging and storage boxes
	Unit serialization	Required except for packaging and storage boxes
Material review	Formal material review board (MRB)	Required for major transportation devices and launch support equipment
Correction action	Corrective action	Required
Configuration verification	Accepted tag	Required; attached to hardware
	Quality assurance configuration verification	Required for alignment fixtures and transportation and launch support equipment; computerized verification system, not required
	Drawing and specification	In accordance with the project configuration management plan

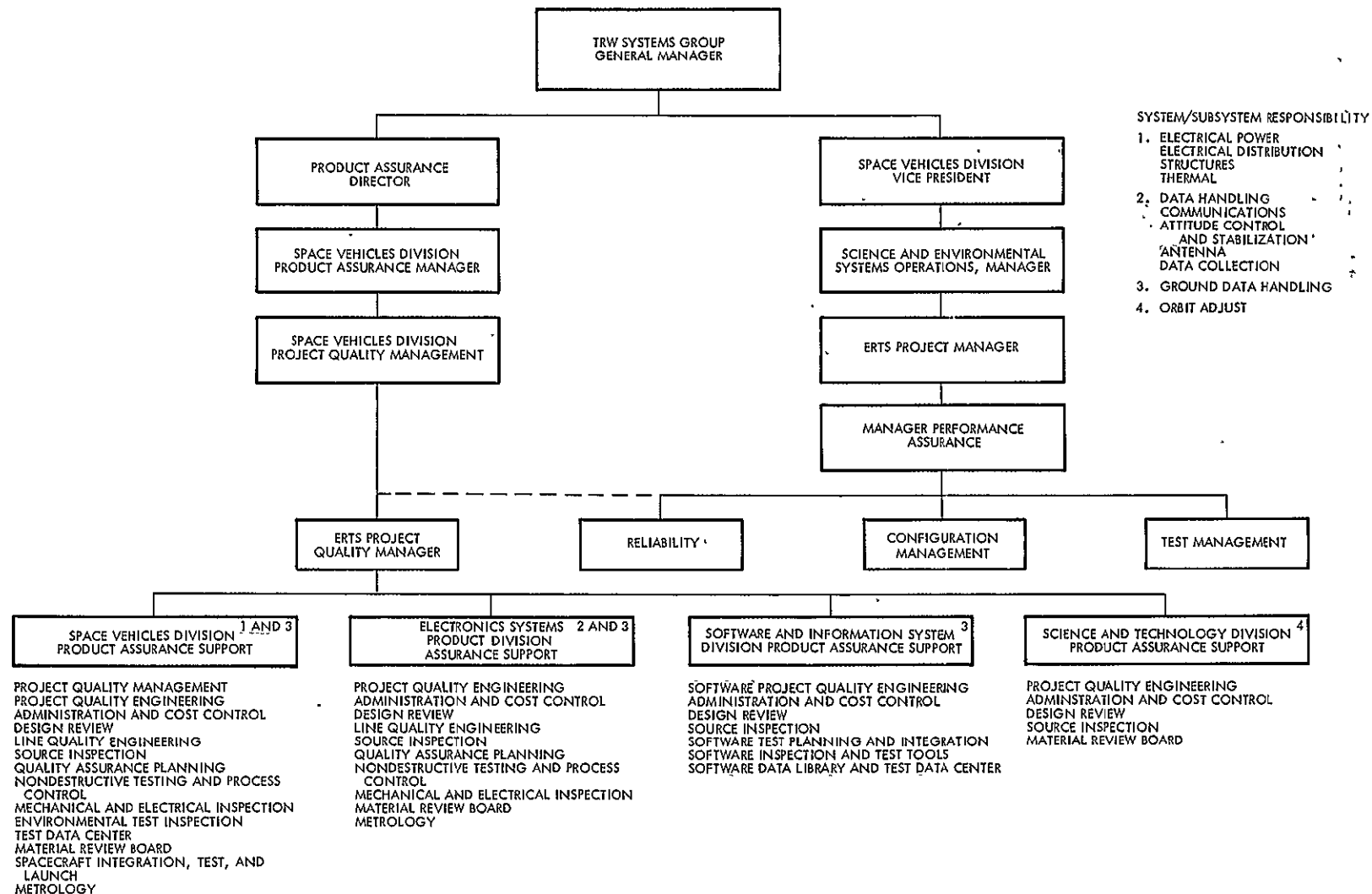


Figure 2-1

INTERRELATIONSHIP BETWEEN ERTS PROJECT OFFICE AND PRODUCT ASSURANCE

Table 2-4. Quality Work Task Description for Project Quality Management

Item Number (Task)	Divisional Management Policy	NHB 5300.4 (1B)	QASP - Applicable Number	SQI - Applicable Number	Task Description	Project Management Task Identified to Project Phase						
						Pre-Proposal and Proposal Phase	Contract Go-Ahead Phase	Procurement Phase	Design Development Phase	Fab Integration and Test Phase	Shipment and Launch Phase	GDHS Development and Operation
1	X		1.1		Request for Proposal Evaluation Review the request for proposal and associated customer specifications and documentation. Prepare a statement to the project office defining questionable areas which need resolution before the quality program can be planned and considered. Resolve questionable area.	X						
2	X		1.1		Preliminary Quality Assurance Requirements Brief. Prepare a preliminary quality assurance requirements brief defining items of a specialized nature such as, traceability, hi-rel screening, and process controls and issue to the project office, engineering, manufacturing, test, and product assurance, so that these requirements are known for program proposal planning and preparation	X						
3		206	1.1		Preliminary Quality Assurance Plan. Prepare a preliminary quality assurance plan and submit to project office and other affected subprojects for comments and interface-problem resolution. Finalize preliminary plan for inclusion in proposal.	X						
4	X				New Quality Assurance Technology Requirements. Identify and assess new quality assurance technology requirements, capital equipment, and revisions to revised process specifications and coordinate with management and special discipline areas so that new requirements may be considered and implemented.	X						
5		500	3 0	3'0.4	Preliminary Vendor Quality Assurance Requirements Document. Prepare preliminary vendor quality assurance documents which define the procurement quality requirements for major subcontractors and suppliers. Submit to material for attachment to subcontractor/supplier request for proposals.	X						
6	X		1.1		Product Assurance Proposal Coordination. Prepare for and conduct product assurance proposal kick-off meetings to discuss the above requirements and to establish costing ground rules and schedules	X						

Table 2-4. Quality Work Task Description for Project Quality Management (Continued)

Item Number (Task)	Divisional Management Policy	NHB 5300.4 (1B)	QASP - Applicable Number	SQI - Applicable Number	Task Description	Project Management Task Identified to Project Phase						
						Pre-Proposal and Proposal Phase	Contract Go-Ahead Phase	Procurement Phase	Design Development Phase	Fab Integration and Test Phase	Shipment and Launch Phase	GDHS Development and Operation
7	X		1.1		Work Breakdown Structure, Work Package Dictionary, and Estimates. Prepare a project quality assurance work breakdown structure and work package dictionary, estimate quality project office costs, review and approve subsponsor divisions' costs and submit the total cost package to the project office for review and fact finding.	X						
8	X		1.1		Proposal Rationale and Support Data. Prepare a quality assurance negotiations work package with detailed justification and rationale back-up. Support fact finding and negotiations with the customer.	X						
9	X				Contract Work Statement. Upon contract go-ahead, compare the new contract work statement and supporting documentation to the original request for proposal requirements and identify differences to the project office and higher management. Resolve anomalies and associated quality assurance systems and financial considerations		X					
10	X		1.1		Contract Brief and Orientation. Prepare a quality assurance contract brief which describes the quality assurance work statement, supporting specifications, list of deliverables, and a quality assurance milestone/schedule chart. Distribute to project office and functional organizations. Hold requirements orientation meetings with interfacing organizations.		X					
11	X	206	1.1		Formal Quality Assurance Plan. Prepare the formal quality assurance plan, submit to management and project office for review, finalize, reproduce, and submit to the customer for approval. Participate in plan evaluations by the customer, negotiations, and incorporate changes to the baseline plan.		X					
12	X				Project Work Authorizations. Approve and issue project work authorizations to subsponsor divisions which include task descriptions, budgets, and schedule requirements in conjunction with the quality assurance project work breakdown structure. Maintain on an up-to-date status throughout life of the program.	X	X	X	X	X	X	X

Table 2-4. Quality Work Task Description for Project Quality Management (Continued)

Item Number (Task)	Divisional Management Policy	NHB 5300.4 (1B)	QASP - Applicable Number	SQI - Applicable Number	Task Description	Project Management Task Identified to Project Phase						
						Pre-Proposal and Proposal Phase	Contract Go-Ahead Phase	Procurement Phase	Design Development Phase	Fab Integration and Test Phase	Shipment and Launch Phase	GDHS Development and Operation
13			3 0 1.1	3.0 4 1.1 1 1.2.1	Project Quality Instructions Prepare and issue internal project quality assurance instructions which identify project peculiar quality requirements, customer mandatory inspection points, special contract requirements, military specification applicability, traceability, requirements, and release through the formal document control system.	X	X	X	X	X	X	X
14	X	503 504	4.0	4.0.2	"Make or Buy" Committee and Source Inspection Determination. Review "make or buy" list and participate in the "make or buy" decision committee process. Establish source inspection, residency, and surveillance requirements (based upon the type and criticality of the hardware).			X				
15		501 507 508 510	3.0	3.0.1 3.0.3	Subcontractor/Supplier Surveys. Conduct or arrange for major and subcontractor/critical supplier surveys from the quality office.. Negotiate and resolve deficiencies with subcontractor/critical supplier's quality systems. Maintain follow-up and records.			X				
16		501	3.0	3.0.4	Subcontractor/Supplier Quality Plans. Review and approve major subcontractor critical suppliers' quality assurance plans in accordance with vendor quality requirement documents, resolve deficiencies and approve the plans.			X				
17		507 508 510	3.0	3.0.1	Preferred Suppliers Directory/Corrective Action. Review the quality assurance supplier directory (weekly tab run) for supplier's submitting defective materials and components, coordinate with vendor quality assurance group and have formal corrective action notices sent to the supplier(s).			X				
18	X	300 301			System Project Design Reviews. Contribute to project design reviews policies and participate in systems project design reviews. Close-out action items and maintain associated records.				X			X
19	X	202			Special Skills and Training. Identify special skills and training needs, and prepare and implement appropriate plans when requirements and needs are different than standard techniques or skills presently available for in-house work.				X	X	X	X

Table 2-4. Quality Work Task Description for Project Quality Management (Continued)

Item Number (Task)	Divisional Management Policy	NHB 5300.4 (1B)	QASP - Applicable Number	SQI - Applicable Number	Task Description	Project Management Task Identified to Project Phase						
						Pre-Proposal and Proposal Phase	Contract Go-Ahead Phase	Procurement Phase	Design Development Phase	Fab Integration and Test Phase	Shipment and Launch Phase	GDHS Development and Operation
20		701	16.0 4.0	16.0.1 4.0.6	Planning and Quality Assurance Controls. Review quality assurance planning in conjunction with subsponsor quality assurance groups at their black box and critical item level for adequacies of quality assurance controls and for the implementation of customer mandatory inspection points as required.			X	X	X	X	X
21	X	300 301 702 703 704			Specification and Test Procedure Policy. Participate as a policy member in determining policy and ground rules for system, subsystem, and equipment specifications; bench, environmental acceptance, qualification, life, and major systems test procedures.					X		X
22	X	300 702 703 704			Specification and Test Procedure Review. Review the above list of specifications and procedures for quality assurance requirements and coordinate comments and anomalies that exist in the procedures and specifications.				X	X		X
23		600 601 602 603 604 705 707 802	16.0	16.0.1	Manufacturing Inspection, Test, and Performance. Review performance of manufacturing inspection, test, and integration operations across the company for compliance to project quality assurance requirements, initiate corrective action as required.			X	X	X	X	X
24	X		4.0	4.0.8 4.0.9 4.0.7	Test and Failure Review Boards. Participate in the establishment of test data package/test failure review board policies. Participate as a member of the project Test Review and Failure Review Boards.					X	X	X
25		203 802	15.0	15.0.1	Manufacturing and Test Defect Trend Data. Develop and maintain a product trend list of manufacturing and test defects from the various product assurance problem-reporting techniques. Coordinate with other product assurance groups and take appropriate corrective action. Submit status to project office and customers as required.				X	X		X
26		1100 1101 1102	4.0	4.0.11	Preservation, Packaging, Handling, Storage, and Shipping. Review drawings and procedures for preservation, packaging, handling, storage, shipping contract end items for compliance to quality requirements of the contract.						X	X

Table 2-4. Quality Work Task Description for Project Quality Management (Continued)

Item Number (Task)	Divisional Management Policy	NHB 5300 4 (1B)	QASP - Applicable Number	SQI - Applicable Number	Task Description	Project Management Task Identified to Project Phase						
						Pre-Proposal and Proposal Phase	Contract Go-Ahead Phase	Procurement Phase	Design Development Phase	Fab Integration and Test Phase	Shipment and Launch Phase	GDHS Development and Operation
27		705 706	4 0	4 0.11	End-Item and Shipping Data Acceptance. Present end-item data and shipping data to responsible customer representative per established project plan and customer instructions for review and acceptance.						X	X
28	X	1102	4.0	4.0.11	Shipping Activities Support or supervise shipping inspection operations and the loading, unloading, and transportation of articles to destination.							X
29		800 801 805	9 0	9.0.2 9.0.5	Field Returns Instructions. Issue instructions for quality assurance requirements relating to company or customer material returned from the field for inspection, repair, modification, etc. Coordinate customer approval as required.							X
30	X	200 206	17.0		Launch Site Quality Assurance Plan. Prepare a separate quality assurance plan which defines in detail the receiving of items at launch site, bonded storage, handling of data, provisions for MRB, TRB, inspection, checkout, and post-launch shipment of spares and EAGE back to TRW facilities							X
31		300 301	10.0	10 0.1	Control of Government Property. Establish special quality procedure for control of government property per contract requirement if not covered in SQI 10.0.1.					X		X
32	X	101			Associated Subproject Plan Review. Review other project and subproject plans (reliability, maintainability, procurement, configuration management, etc.) for compliance to quality assurance requirements and other product assurance requirements.	X	X	X	X	X	X	X
33		900	2.0	2.0.1 2.0.2 2.0.3	Project Metrology Requirements. Compare TRW calibration and maintenance standards to project/contract particularly in areas of special and factory test equipment. Arrange for preparation of special instructions as required. Participate in test equipment validation and compatibility policy decisions.				X	X	X	X
34	X	206			Project Budgeting and Cost Control. Issue and maintain overall quality assurance project manpower planning, budgeting, and cost control. Establish periodic coordination meetings with subsponsor divisions.	X	X	X	X	X	X	X
35		204			Project Status Reports. Prepare project status reports for the project office, customers, and management on a scheduled basis.	X	X	X	X	X	X	X

The director of TRW product assurance reports directly to the general manager (see Figure 2-2). While maintaining a centralized and independent position for complete quality assurance, the product assurance organization has been adapted to encompass divisional product line quality functions by appointment of divisional product assurance managers. For the ERTS program, the Space Vehicles Division product assurance manager has assigned a project quality manager (PQM) who reports and receives direction regarding quality from the department manager of Project Quality Management, Space Vehicles Product Assurance. He receives contractual requirements, budgets, and schedules from the ERTS manager of performance assurance. The project quality manager (PQM) is responsible for the definition, interpretation, implementation, and application of the quality requirements. He provides comprehensive quality direction and management of the quality program for the ERTS project.

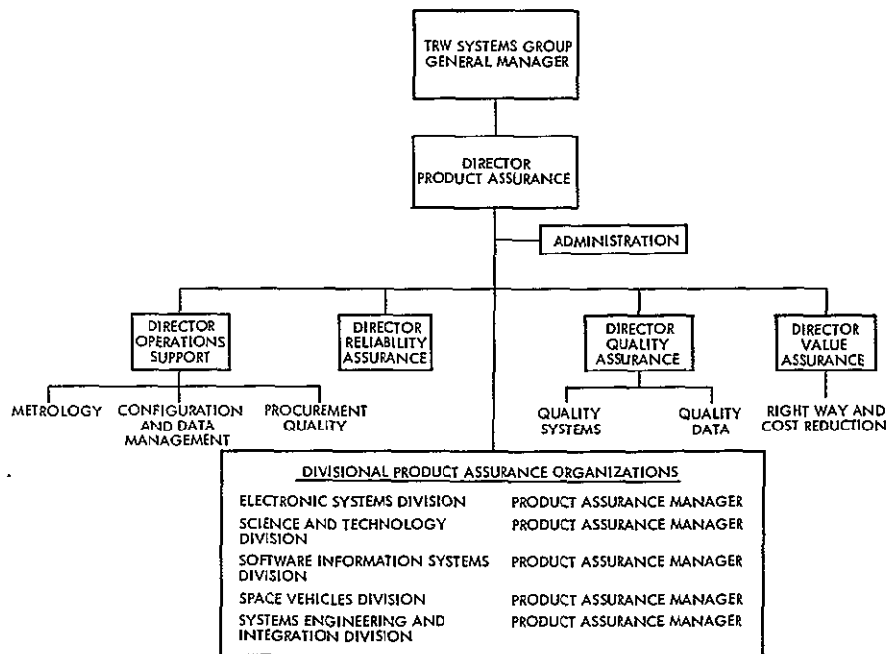


Figure 2-2

## TRW SYSTEMS GROUP PRODUCT ASSURANCE ORGANIZATION

Within the framework of this organizational structure, work packages are released to the performing quality assurance organizations from the ERTS project office with the cognizance of the project quality manager. The quality work task description for supporting project quality requirements are described in Table 2-5.

The quality assurance function, encompassing management, quality engineering, test observation, and inspection, is performed by personnel who report functionally to the division product assurance organizations. The corporate product assurance organization is subdivided into product line elements, each of which is assigned in an operational sense to support line division. Each product line element is organized to meet the particular quality needs of the assigned division. These needs range from planning and implementing a quality program, where the division is a project sponsor, to providing quality assurance support on a subsystem basis where the division performs in a supporting role.

Thus, each product line quality assurance organization operates essentially as a separate entity, taking general policy direction from the corporate product assurance organization and project direction from the project quality manager.

The project quality manager for the ERTS project provides quality program planning and establishes the requirements for quality assurance activities in support of the project. He monitors the performance of quality tasks throughout the company to assure compliance with those requirements. In performing divisions, project quality engineers (PQE's) have been assigned to assure that project quality requirements are met. An essential part of the management concept is the identification of all quality functions by task and subproject so that the relationship of quality costs to a hardware item can be maintained. Quality assurance work tasks are identified in tables and inserted into appropriate sections of this plan. These basic quality work task descriptions are included for both the ERTS spacecraft and data handling systems. They are general in nature and are considered as part of this plan and have been added for reference purposes only. Table 2-6 is the work task description specifically for operational software quality.

Table 2-5. Quality Work Task Description for PQE - Project Quality Engineering, LQE - Line Quality Engineering, TQE - Test Quality Engineering, ADM - Administration and Cost Control, and SQE - Staff Quality Engineering

Item Number (Task)	Divisional Management Policy	NHB 5300.4 (1B)	QASP - Applicable Number	SQI - Applicable Number	Task Description	Project Management Task Identified to Project Phase						
						Pre-Proposal and Proposal Phase	Contract Go-Ahead Phase	Procurement Phase	Design Development Phase	Fab Integration and Test Phase	Shipment and Launch Phase	GDHS Development and Operation
1	X		1.1		Estimate Quality Assurance Task and Manpower. Estimate quality assurance manpower cost in accordance to the project quality assurance work breakdown structure, preliminary quality assurance plan, and quality work tasks. Develop supporting rationale to support project office, management, and customer fact finding. (PQE) (ADM)	X						
2	X	206	1.1		Budgets, Work Authorizations, Cost Control, and Tasks. Prepare and coordinate project work authorizations to sub-sponsor divisions which include task descriptions, budgets, and schedule requirements in conjunction with the quality assurance project work breakdown structure and maintain and update on a periodic basis throughout the life of the program. Maintain continuous project cost control, estimate project changes in scope, and exercise periodic cost-to-completes. (PQE) (ADM)		X	X	X	X	X	X
3	X	300 301			Design Review. Participate in subsystem, and unit design reviews number two and three for design requirements versus capabilities, tolerances, equipment specification parameters, procedures for receiving inspection, high reliability screening, special processes, and associated need for quality operating instructions, overall design problems known from previous design, special test equipment needs, and calibration and test procedures meeting equipment specification requirements. Accept action items and closeout action items in a timely period. (PQE) (LQE)				X			X
4	X	301 705			Engineering Model Evaluation. Review engineering model performance data and coordinate with design engineers for elements or anomalies that can be used for planning and establishing quality controls on special characteristic items. (PQE)				X			X
5		600 601	4.0	4.0.4	Controls on Production Devices Directly Affecting Quality. Assist manufacturing engineering in specifying the required quality capability of new production devices directly affecting quality such as drill fixtures, equipment, and tooling used for inspection acceptance. (LQE)				X	X		

Table 2-5. Quality Work Task Description for PQE - Project Quality Engineering, LQE - Line Quality Engineering, TQE - Test Quality Engineering, ADM - Administration and Cost Control, and SQE - Staff Quality Engineering (Continued)

Item Number (Task)	Divisional Management Policy	NHB 5300 4 (1B)	QASP - Applicable Number	SQI - Applicable Number	Task Description	Project Management Task Identified to Project Phase						
						Pre-Proposal and Proposal Phase	Control Go-Ahead Phase	Procurement Phase	Design Development Phase	Fab Integration and Test Phase	Shipment and Launch Phase	GDHS Development and Operation
6		602 603 604	5.0		Quality Capability Requirements. Determine that manufacturing processes and equipment have sufficient capability to meet quality requirements by analyzing process-capability studies, control charts, and other statistical data. Determine which product- and process-quality characteristics require process-capability studies. Analyze results of studies and feedback recommendations for selection or improvement of machine or process to meet manufacturing quality requirements. (LQE)				X	X		
7	X	203 206	7.0	7.0.1	Manufacturing and Test Quality Problems. Diagnose manufacturing and test quality problems referred by process control engineering or line quality engineering to determine basic cause or difficulties. Provide technical assistance as required to other functions. Present analysis of facts to establish the nature of the problem for solution and action by the appropriate group. Follow up and report progress to applicable management. (PQE) (LQE) (TQE)				X	X		X
8	X		1.1		Quality Cost Analysis. Analyze all elements of quality costs and provide analyses as a basis for initiating positive action in the areas of prevention, appraisal, and failure, for overall reduction in quality costs. (PQE) (LQE) (ADM) (TQE)			X	X	X	X	X
9		202	5.0	5.0.2	Quality Training. Develop and implement project quality orientation programs for all operational personnel in the company to ensure understanding of quality control objectives, programs, plans, and techniques. Provide quality training programs for personnel in manufacturing operations and other subfunctional components. (PQE) (LQE) (TQE)				X	X		X
10		203 204	1.1	1.1.1	Quality Communication. Develop and initiate efficient methods for regularly reporting to managers and other interested personnel the current status of product quality with respect to quality objectives and goals to simulate quality improvement and continued quality efforts. Keep management regularly informed on status and progress made on quality control programs and plans. (PQE) (LQE) (TQE) (ADM)	X	X	X	X	X	X	X

Table 2-5. Quality Work Task Description for PQE - Project Quality Engineering, LQE - Line Quality Engineering, TQE - Test Quality Engineering, ADM - Administration and Cost Control, and SQE - Staff Quality Engineering (Continued)

Item Number (Task)	Divisional Management Policy	NHB 5300.4 (1B)	QASP - Applicable Number	SQI - Applicable Number	Task Description	Project Management Task Identified to Project Phase						
						Pre-Proposal and Proposal Phase	Contract Go-Ahead Phase	Procurement Phase	Design Development Phase	Fab Integration and Test Phase	Shipment and Launch Phase	GDHS Development and Operation
11		103 206	1.1	1.1.1 3.0.4 1.2.1	Quality Systems Manuals. Write and furnish quality system procedures, QASP's, SQI's, and QI's and needed quality assurance forms. (LQE) (PQE) (TQE)	X	X	X	X	X	X	X
12		103 206	1.1 3.0	1.1.1 3.0.4 1.2.1	Project Peculiar Instructions. Write and furnish quality system procedures, such as project peculiar quality instructions and quality operating instructions including traceability, special handling, and process controls. (PQE) (TQE)		X	X	X	X	X	X
13	X	600 900 901 902	4.0 2.0	4.0.4 2.0.2	Test and Inspection Equipment Design. Design construct, and proof in required testing equipment, inspection tools, fixtures, and gauges or procure this equipment or service. Plan for continued effectiveness of such equipment and tooling, including calibration schedules. (LQE) (TQE)				X	X		X
14		600 601 603 700 701 900 901 902 905	4.0 2.0	4.0.4 2.0.2	In-Process Quality Measuring Devices. Ensure that in-process quality-measuring devices are provided to indicate, and in some cases record, the quality at the instant it is produced so the operator can provide rapid control of the process and have proof of in-process quality. Plan for continued effectiveness of such devices, including calibration schedules. (LQE) (TQE)				X	X		X
15		600	2.0	2.0.2	Mechanization and Automation. Work with manufacturing and test engineering to incorporate, where possible, the quality measurement and control devices with the manufacturing and test equipment to provide optimum mechanization and automation through integrated analysis and feedback of quality data. (LQE) (TQE)				X	X		
16		600	2.0	2.0.2	Advanced Quality Measured Techniques and Equipment. Devise, develop, and prove feasibility of advanced quality-measurement, and control techniques and equipment required to achieve continually improving manufactured product quality, including reliability, at reduced costs. (PQE) (LQE) (TQE)		X	X	X	X		
17		206 205	1.0 16.0	1.1.1 16.0.1	Appraise the Quality Plan. Appraise the continuing effectiveness of the quality plan in terms of quality levels, nature of manufacturing and test quality problems, customer complaints, and economical operation as the result of implementing and working with the plan. (PQE) (LQE) (TQE)	X	X	X	X	X	X	X

Table 2-5. Quality Work Task Description for PQE - Project Quality Engineering, LQE - Line Quality Engineering, TQE - Test Quality Engineering, ADM - Administration and Cost Control, and SQE - Staff Quality Engineering (Continued)

Item Number (Task)	Divisional Management Policy	NHB 5300.4 (1B)	QASP - Applicable Number	SQI - Applicable Number	Task Description	Project Management Task Identified to Project Phase						
						Pre-Proposal and Proposal Phase	Contract Go-Ahead Phase	Procurement Phase	Design Development Phase	Fab Integration and Test Phase	Shipment and Launch Phase	GDHS Development and Operation
18		206	1 1	1.1.1	Interpretation of Quality Plan. Furnish to manufacturing operation and other organization components all necessary interpretation of the quality plan, its use, operation, and intent. (PQE) (LQE) (TQE)	X	X	X	X	X	X	
19		200 205 206	4.0	4.0.6	Review and Maintain Quality Standards. Inspect quality standards, both written and physical, for clarity and furnish interpretation to assure understanding and proper use. Provide for the maintenance of quality standards. (LQE)				X	X	X	X
20		205	4.0	4.0.6	Determine Conformance to Quality Planning. Provide to manufacturing operations and others an evaluation of conformance to quality planning to aid in making effective use of such planning as to the adequacy of the operational callouts. (PQE) (LQE) (TQE)				X	X		X
21		206	4.0	4.0.6	Temporary Quality Planning. In urgent situations, when not prescribed in the quality plan, provide manufacturing and test operations temporarily with inspection test, and process-control criteria, procedures, and measurements. (PQE) (LQE) (TQE)				X	X		X
22	X				Contribute to Reducing Quality Costs and Manufacturing Losses. Seek out and demonstrate ways and means for reducing costs and manufacturing losses. Work closely with quality control engineering, manufacturing engineering, and manufacturing operations in effecting such improvements.			X	X	X	X	X
23	X	703 705			Product Special Testing. Conduct or arrange for special tests as an aid to engineering and other organizational groups for product development, product specification development, and new processes and equipment development (radiographic, ultrasonic, penetrant, etc.). (PQE) (LQE) (TQE)				X	X		X
24		703 705	5.0	5.0.1	Laboratory Tests, Measurements, and Analyses. Make or arrange for laboratory tests, measurements, and analyses of materials, processes, and products for process- and product-quality control. Provide special tests and measurements as required. (PQE) (LQE) (TQE)				X	X		X

Table 2-5. Quality Work Task Description for PQE - Project Quality Engineering, LQE - Line Quality Engineering, TQE - Test Quality Engineering, ADM - Administration and Cost Control, and SQE - Staff Quality Engineering (Continued)

Item Number (Task)	Divisional Management Policy	NHB 5300.4 (1B)	QASP - Applicable Number	SQI - Applicable Number	Task Description	Project Management Task Identified to Project Phase						
						Pre-Proposal and Proposal Phase	Contract Go-Ahead Phase	Procurement Phase	Design Development Phase	Fab Integration and Test Phase	Shipment and Launch Phase	GDHS Development and Operation
25		800	9.0	9.0.0	Material and Product Disposition. Investi-			X	X	X	X	X
		801		9.0.1	gate problems, nonconforming materials,							
		802		9.0.2	components, products and discrepant							
		803		9.0.3	paperwork for causes. Work closely with							
		804		9.0.4	engineering, manufacturing engineering,							
				9.0.5	materials, and manufacturing operations,							
					for prompt and economic use or disposition							
					and for correction of the cause for non-							
					conformance. (PQE) (LQE) (TQE)							
26		204	1.1		Customer/DCAS Contacts. Work closely	X	X	X	X	X	X	X
		805			with the customer's inspection or quality							
					representative as to current quality prob-							
					lems. Interpret standards, specifications,							
					quality requirements, and quality planning							
					for in-plant customer inspection. Coordi-							
					nate government mandatory inspection							
					points and resolve quality deficiency							
					reports (QDR's). (PQE) (LQE) (TQE)							
27		203	5.0	5.0.1	Determine Process and Equipment Quality				X	X		
		600			Capability. Perform quality capability							
		602			studies of processes and manufacturing							
		603			equipments, tools, and dies to assist in							
		604			the solution of manufacturing quality							
					problems and to provide quality information							
					to be used in improving the methods. (LQE)							
28	X				Safety. Provide safety rules and practices				X	X	X	X
					for use in the design, operation, and							
					maintenance of quality test and inspection							
					equipment. Inspect designs and resulting							
					quality information equipment for safety.							
					Establish and maintain safe working condi-							
					tions, equipment, and procedures for all							
					such equipment used in the component.							
					Advise managers as to safety training							
					needs and provide for the training of users							
					of quality test equipment. (PQE) (LQE)							
					(TQE)							
29		500	3.0	3.0.4	Vendor Quality Documentation. Support	X	X					
					the preparation of the vendor quality							
					assurance document (PAR series), defining							
					all the quality system requirements and							
					documentation that are to be imposed on							
					the two major categories of suppliers							
					(major subcontractors for critical hardware							
					and suppliers of less critical hardware).							
					Define special requirements, such as							
					traceability, documentation approvals, and							
					associated company or government specifi-							
					cations that apply and standard and quality							
					clauses per systems instruction 3.0.4							
					(PQE)							

Table 2-5. Quality Work Task Description for PQE. - Project Quality Engineering, LQE - Line Quality Engineering, TQE - Test Quality Engineering, ADM - Administration and Cost Control, and SQE - Staff Quality Engineering (Continued)

Item Number (Task)	Divisional Management Policy	NHB 5300.4 (IB)	QASP - Applicable Number	SQI - Applicable Number	Task Description	Project Management Task Identified to Project Phase					
						Pre-Proposal and Proposal Phase	Contract Go-Ahead Phase	Procurement Phase	Design Development Phase	Fab Integration and Test Phase	Shipment and Launch Phase
30		804	9.0	9.0.0	Material Review Board. Participate as a member of the material review board.			X			X
				9.0.1	Consult with reliability and other engineering specialists to arrive at disposition actions. Assure associated documentation is complete and verify the corrective action initiated. Maintain board area and files. (PQE) (LQE) (TQE)						X
				9.0.2							
				9.0.3							
				9.0.4							
				9.0.5							
31		705	4.0	4.0.8	Test Review Board. Determine test data package, contents, assure the proper flow of documentation to the test data center, review test data packages for completeness, and participate as a member of the test review board for evaluation of the integrity, method, conduct, performance, and completeness of the test. Verify documentation approvals and verify that changes to the test procedure or specification are legitimate. (PQE) (TQE)					X	X
		706		4.0.9							
				4.0.7							
32		706	4.0	4.0.8	Failure Review Board. Participate as a member of the failure review board, identify those problems where quality assurance controls need to be initiated or modified and areas within suppliers' system that need corrective action. Place emphasis on repetitive type failures. (PQE) (TQE)					X	X
				4.0.9							
				4.0.7							
33	X	701			Test Procedure Review and Approval. Contribute to the establishment of test procedure review and approval policy, perform the reviews to assure the adequacy of the quality and test data requirements, and provide the criteria necessary to verify conformance to these requirements. Develop appropriate quality review checklists and assure that test procedures do not go through the system "open loop." Approve fabrication bench, acceptance, and systems test procedures. (PQE) (TQE)					X	X
		703									
		704									
34		706	14.0	14.0.1	Observatory Logs and Records. Establish the observatory logbook and record policy and specify format and sequence of record accumulation. Periodically verify that requirements are being adhered to. (PQE) (TQE)					X	X
35		705	5.0	5.0.1	Nondestructive Test Engineering. Participate in the review and drawings pinpointing x-ray, penetrant, infrared, magnetic particles, and ultrasonic testing needs and requirements. Assist engineering and manufacturing in determining new or improvised and proper techniques for applying NDT technology. (LQE)			X	X	X	X

Table 2-5. Quality Work Task Description for PQE - Project Quality Engineering, LQE - Line Quality Engineering, TQE - Test Quality Engineering, ADM - Administration and Cost Control, and SQE - Staff Quality Engineering (Continued)

Item Number (Task)	Divisional Management Policy	NHB 5300.4 (1B)	QASP - Applicable Number	SQI - Applicable Number	Task Description	Project Management Task Identified to Project Phase						
						Pre-Proposal and Proposal Phase	Contract Go-Ahead Phase	Procurement Phase	Design Development Phase	Fab Integration and Test Phase	Shipment and Launch Phase	GDHS Development and Operation
36		1101 1102	12.0	12.0.1	Packaging and Shipping. Determine the packaging and preservation methods most suitable for the handling and shipping of in-process and deliverable end items. Assure that requirements are properly documented and establish a system for verifying that the requirements are adhered to. (PQE) (LQE) (TQE)					X	X	X
37		200 302	18.0	18.0.1	Change Evaluation Board. Participate as a member of the change evaluation board and review all engineering changes for their effectivity and acceptability for implementation in the manufacturing area. Assure that they contain sufficient criteria and clarity for inspection acceptance. (PQE)				X	X		X
38		300			System and Equipment Specification Review. Review system, subsystem, equipment, interface, environmental, and test specifications to assure that they adequately meet the top system specification requirements and that they are of sufficient clarity to be used for designing test parameter requirements. Assure that there is compatibility between the system and equipment type specifications and the environmental specifications. (PQE)			X	X	X		X
39		300 603			Assembly Test and Material Parts Specifications. Review assembly parts, materials processes, finishes, and packaging specifications to assure that they are acceptable to use for end-item acceptance. On parts specifications, review and approve the suppliers process identification document (PID). Update quality assurance instructions to meet project requirements when process specifications are reviewed. (PQE) (LQE)			X	X	X		
40		705	4.0	4.0.5	Approval of "First Article." Coordinate with the unit engineer, manufacturing engineering, and materials and process engineering and have joint approval of the "first article" inspection. If anomalies exist, follow up to assure that anomalies are resolved. (PQE)					X		

Table 2-5. Quality Work Task Description for PQE - Project Quality Engineering, LQE - Line Quality Engineering, TQE - Test Quality Engineering, ADM - Administration and Cost Control, and SQE - Staff Quality Engineering (Continued)

Item Number (Task)	Divisional Management Policy	NHB 5300.4 (1B)	QASP - Applicable Number	SOI - Applicable Number	Task Description	Project Management Task Identified to Project Phase						
						Pre-Proposal and Proposal Phase	Contract Go-Ahead Phase	Procurement Phase	Design Development Phase	Fab Integration and Test Phase	Shipment and Launch Phase	GDHS Development and Operation
41	205	16.0	16.0.1		Systems Audits. Perform quality audits periodically to monitor the activities performed by those organization elements that are responsible for or have an effect upon product quality (to include systems effectiveness audits, functional operations audits, division audits, division policy implementation, and special cross-divisional audits. Report results to management for corrective actions. Follow up to assure that corrective action has been implemented. (SQE)	X	X	X	X	X	X	X
42	205	16.0	16.0.1		Project Peculiar Quality Management Audit. Perform project peculiar audits to assure that project amendments to system quality instructions have been implemented in accordance with the project quality plan. Audit areas outside of quality assurance's responsibility including material control stores, integration stores, integration and test for possible affect on quality performance. (PQE) (SQE)			X	X	X	X	X
43	205	16.0	16.0.1		Line Quality Engineering and Inspection Audits. Examine project hardware previously accepted by quality assurance to determine how effective the quality assurance personnel are in assuring that manufacturing hardware meets design requirements and specifications and that quality assurance instructions and acceptance criteria are adequate to perform the inspection function. (LQE)					X		
44	202 603	5.0	5.0.1		Special Process Control and Certification. Perform mechanical, electrical, and chemical test analysis to establish process capability and repeatability. Establish and maintain certification and control of special processes which include the following: welding, brazing, soldering, plating, heat treating of metals, mechanical surface treatment, NDT, contamination control, and measurement. Utilize TRW process specification and applicable military, NASA, and federal specifications and standards. Perform recertification at intervals established according to specifications, contractual requirements, and evidence of process repeatability. (SQE)				X	X	X	

Table 2-5. Quality Work Task Description for PQE - Project Quality Engineering, LQE - Line Quality Engineering, TQE - Test Quality Engineering, ADM - Administration and Cost Control, and SQE - Staff Quality Engineering (Continued)

Item Number (Task)	Divisional Management Policy	NHB 5300.4 (1B)	QASP - Applicable Number	SQI - Applicable Number	Task Description	Project Management Task Identified to Project Phase					
						Pre-Proposal and Proposal Phase	Contract Go-Ahead Phase	Procurement Phase	Design Development Phase	Fab Integration and Test Phase	Shipment and Launch Phase
45		203	15.0	15.0.2	Quality Performance Reports. Publish weekly quality performance reports which include: initial item inspections, initial item rejections, rework item inspections, rework item rejections, initial inspection hours, initial item defects per 100 manufacturing hours, percent rejected/initial inspections, percent rejected rework inspection, percent of total hours expended on rework (manufacturing and inspection, average cost per defect in dollars), total inspection hours as percentage of total manufacturing hours, average defects per rejection equals initial item inspection, average defects per rejection - rework item inspection, initial inspection hours as percentage of total manufacturing hours. In addition, publish reports which specify the ten most recurring defects by defect category. Reports should include project, division, and skill center identification for the purpose of implementing corrective action. (SQE)	X	X	X	X	X	X
		204	7.0	7.0.1							
		507									
		706									
		801									
		802									
46		203	15.0	15.0.1	Corrective Action. Review supplier and in-house quality performance records and defect trend reports and repetitive type rejects, noncompliance to quality assurance system requirements, and errors that may have been prevented. Issue formal corrective action notices to the persons or organizations responsible and follow up to assure that corrective action has been implemented. (PQE) (LQE) (TQE)	X	X	X	X	X	X
		204		15.0.2							
		802									
47		1200	4.0	4.0.3	Sampling Techniques. Develop, prepare, and maintain sampling plans in accordance with MIL-STD-105 and MIL-STD-414 and establish acceptable quality levels to be imposed and the degree of inspection severity (normal, reduced, or tightened). Analyze quality levels and update plans on a periodic basis. (PQE) (SQE)	X	X	X	X	X	X
		1201									
48		1000	8.0	8.0.1	Quality Assurance Stamps. Maintain a system and provide instructions for the implementation and use of quality assurance stamps to be used when designating inspection, acceptance, and rejection of hardware and documentation. (SQE)	X	X	X	X	X	X
		1001									

Table 2-5. Quality Work Task Description for PQE - Project Quality Engineering, LQE - Line Quality Engineering, TQE - Test Quality Engineering, ADM - Administration and Cost Control, and SQE - Staff Quality Engineering (Continued)

Item Number (Task)	Divisional Management Policy	NHB 5300 4 (1B)	QASP - Applicable Number	SQI - Applicable Number	Task Description	Project Management Task Identified to Project Phase						
						Pre-Proposal and Proposal Phase	Contract Go-Ahead Phase	Procurement Phase	Design Development Phase	Fab Integration and Test Phase	Shipment and Launch Phase	GDHS Development and Operation
49		200 302 603			Parts Board, Parts Matrix. Participate as a member of the parts selection board for review of magnetic characteristics, alternative parts and supplier quality history. Provide inputs to the parts matrix to include inspection level, traceability level, source inspection, approved supplier, and magnetic testing. (PQE)			X				
50	X		1.1	1.1.1	Supporting Division Interface. Provide project quality engineering support and direction to supporting quality groups and monitor performance for compliance with project quality requirements. (PQE)	X	X	X	X	X		X

### 1B202 Training

Personnel engaged in fabrication, assembly, test, or the data processing facility will be instructed as necessary in the requirements of the project, the importance of their functions in relation to the total project, the need for sustained high quality, and the methods and procedures to be followed for particular jobs. TRW Systems Group will assist as practicable, subcontractors and suppliers in establishing similar programs within their facilities.

In areas of fabrication and inspection where conformance to critical workmanship standards are necessary, TRW will maintain formal training and certification programs. For example, soldering and welding personnel will be certified. Only those employees who have successfully completed training and certification as specified will perform the certified specialty tasks on ERTS hardware.

Table 2-6. Quality Work Task Descriptions  
for Software Quality

Item Number (Task)	NHB 5300.4 (1B)	Task Description	Quality Assurance Operational Software Tasks Identified to GDHS Project Phase							
			Milestone A	Milestone B	Milestone C	Milestone D	Milestone E		Milestone F	
							II & T TRW	Conditional Acceptance Test		
								Tests at TRW		Tests at GSFC
1	206	Software Quality Management	X	X	X	X	X	X	X	
		Estimate software quality tasks and manpower								
		Estimate quality manpower costs in accordance with work breakdown structure								
		Review all quality work authorizations for adequacy of budget funds								
		Allocate funds into the work breakdown structure								
		Prepare work authorizations for each approved task								
		Implement cost control techniques								
		Prepare cost to complete reports								
		Review labor costs								
		Initiate master schedules for internal and subcontractor work packages								
		Initiate status reports on the general state of GDHS software								
		Support the quality manager in all areas associated with his tasks								
		Monitor and report all internal and subcontractor quality activities associated with GDHS software planning and control administration.								
		Review and coordinate subcontractor quality assurance plans in accordance with vendor quality requirements								
2	300	Programming Standards and Conventions								
	301	a. Coordinating the efforts of the many programmers involved in ERTS. This will ensure that individual programs are produced in an orderly and timely manner and are compatible with each other	X	X	X	X	X	X	X	

Table 2-6. Quality Work Task Descriptions.  
for Software Quality (Continued)

Item Number (Task)	NHFB 5300.4 (1B)	Task Description	Quality Assurance Operational Software Tasks Identified to GDHS Project Phase						
			Milestone A	Milestone B	Milestone C	Milestone D	Milestone E		Milestone F
							II & T TRW	Conditional Acceptance Test	
								Tests at TRW	Tests at GSFC
									Final Acceptance and Demonstration
		b. Making the computer program-understandable so that it may be used and maintained by personnel who were not involved in its design and implementation. This also facilitates the modification of the program if the user requirements change; and the sharing of the program or parts thereof by other users	X	X	X	X	X	X	X
		c. Disseminating information concerning programming techniques which assist in programmer personnel training;	X	X	X	X	X	X	X
		d. Preventing, or at least minimizing, delays in program development due to human error (e.g., oversights in the design of module interfaces, incomplete implementation, or necessary changes).	X	X	X	X			
3	300 301	Software Design Specification Reviews	X	X	X	X			
		Quality assurance personnel will contribute to software design review philosophy and procedures. Quality assurance will support the design review meetings by matching the software documentation against system requirements. Discrepancies will be discussed and action initiated at scheduled design reviews.							
		This support will be provided for:							
		• Design reviews leading to acceptance of Milestones B, C and D							
		• Documentation associated with Milestone E							
		• Inputs to operations manual to enable users to control and operate the computer programs in a field environment							
		• Effectivity of operating limitations and capabilities with respect to actual and planned computer configurations delivered to the field environment							
		• Program revisions and updating documentation.							

Table 2-6. Quality Work Task Descriptions  
for Software Quality (Continued)

Item Number (Task)	NHB 5300.4 (1B)	Task Description	Quality Assurance Operational Software Tasks Identified to GDHS Project Phase						
			Milestone A	Milestone B	Milestone C	Milestone D	Milestone E		Mile- stone F
							II & T TRW	Conditional Acceptance Test	Final Acceptance and Demonstration
								Tests at TRW	
								Tests at GSFC	
4	701	Test Procedure Review		X	X	X	X		
	703								
	704	Review the program design and test procedures to ensure that design requirements are adequately evaluated.							
5	205	Software Quality Planning		X	X	X	X		
	206	Software quality planning work will consist of the following deliverables and engineering services:							
		a. Software Quality Assurance Plan							
		Review quality assurance planning guidelines which identify software peculiar quality requirements, customer mandatory inspection points, special contract requirements overall and continuing compliance with the statement of work, and applicable documents.							
		b. Software Quality Management Audit							
		The quality assurance function involves participation in the development of procedures for software testing throughout the various levels. Quality assurance personnel will monitor the effectiveness of the quality assurance plan and recommend cost-effective changes. Quality Assurance personnel will perform software audits to ensure updates to system quality instructions, in accordance with the project quality plan.							
6	202	Software Source Inspection		X	X	X			
	503								
	504	• Identify, coordinate, and resolve quality deficiencies in conjunction with ERTS Project Office							
	508	• Monitor software subcontractor inplant performance in compliance with contractual quality assurance provisions							

Table 2-6. Quality Work Task Descriptions  
for Software Quality (Continued)

Item Number (Task)	NHB 5300.4 (1B)	Task Description	Quality Assurance Operational Software Tasks Identified to GDHS Project Phase							
			Milestone A	Milestone B	Milestone C	Milestone D	Milestone E		Milestone F	
							II & T TRW	Conditional Acceptance Test		Final Acceptance and Demonstration
								Tests at TRW	Tests at CSFC	
7	707	Test Inspection Surveillance					X	X	X	X
	707	<ul style="list-style-type: none"><li>Observe the acceptance test operations. (Tasks will include compilation and verification of test data.)</li></ul>					X	X	X	X
8	706	Quality Test Data Center (Software)								
		<ul style="list-style-type: none"><li>Ensure resolution of test discrepancies and collect all output data.</li></ul>								

Formal training courses have been established at TRW Systems Group and successful completion of each course is required for certification. Certificates are given for soldering reliable electrical connections, connector assembly soldering, module welding quality and reliability, potting of electrical connections, and module conformal coating and encapsulation.

Certification programs are conducted for such processes as welding, module welding, brazing, soldering, plating, heat treating of metal, chemical surface treatment, nondestructive testing, contamination control, and measurement.

Certification and recertification will be based upon examination of performance; certification cards will be issued. Records of personnel's certification, including complete process identification and certification, are maintained.

### 1B203 Quality Information

Quality assurance maintains several distinct basic systems for the collecting, processing, and analyzing of different categories of quality information and data. A test information retrieval system (TIRS) tabulates and sums test discrepancies, failures, dispositions, and retest data; a quality assurance preferred suppliers directory (QAPSD) lists TRW quality assurance approved suppliers showing current levels of approval and performance appraisals based on suppliers responsible defects; and a standardized quality performance reporting system (SQPRS) is an information system which provides data concerning the level of quality achieved by manufacturing. These systems will be used to the extent necessary to meet ERTS program requirements.

### 1B204 Quality Status Reporting

Quality status reports will be submitted to the customer as directed by the contract. The status reports will contain organization and key personnel changes, significant problems, their resolutions and preventative action, supplier performance, TRW performance trends relative to nonconformances, manufacturing defects, and test reject rates.

### 1B205 Quality Program Audits

Quality assurance maintains a system of random unscheduled audits to periodically monitor the activities performed by those organizational elements that are responsible for and have an effect upon product quality. These audits are performed to evaluate the effectiveness of company policy implementation, ascertain company objectives, measure effectiveness of quality systems and personnel, identify potential problems, assure the fulfillment of project requirements, and improve cost effectiveness.

Quality audits performed at TRW are categorized as follows: company quality system effectiveness audit, functional operations audits, divisional policy implementation audits, project quality management audits, and inspection effectiveness audits. Information from ERTS project quality management audit reports will be submitted to NASA as part of the quality status report. Other internal audit reports, those

encompassing functional organizations and activities supporting other TRW projects, will be maintained by the project quality manager for NASA's review.

#### 1B206 Quality Plan

This quality plan meets the requirements of NHB 5300.4 (1B), "Quality Program Provisions for Aeronautical and Space System Contractors", dated March 20, 1969 and the plan format identified with corresponding chapter and section numbers identical to each cited requirement in NHB 5300.4 (1B).

This plan has been designed to incorporate appropriate quality levels and controls on engineering models, qualification models, prototype models, flight models, mechanical AGE, electrical AGE, and the GDHS equipment. Refer to Table 2-1, "Quality Assurance Controls for Each Type of Model", which lists the types of quality controls that will be applied to each appropriate model on the ERTS project; Table 2-2, "Quality Assurance Controls for Various Types of electrical AGE, GDHS, Electronic GSE and Special Test Equipment", Table 2-3, "Quality Assurance Controls for Mechanical Ground Support Equipment". The respective quality assurance manual section identifies types of controls and associated hardware.

Revisions to the ERTS quality program plan will be generated and approved by the project quality manager, the manager of space vehicles division product assurance and the ERTS manager of performance assurance. It is then submitted to NASA/GSFC for review and approval in accordance with the contract.

## CHAPTER 3: DESIGN AND DEVELOPMENT CONTROLS

### 1B300 Technical Documents

The types of technical documents used at TRW, such as specifications, test procedures, and engineering drawings, are identified in detail in the ERTS configuration management plan. Quality assurance is responsible for conducting reviews of these documents to assure conformance to the ERTS quality program and configuration management plans.

### 1B301 Quality Support to Design Reviews

Design review requirements are identified in the reliability program plan. Quality assurance participates as a member during design review and contributes by:

1. Evaluating components and processes to determine characteristics that could affect product quality.
2. Determining areas in which nondestruct test requirements should be imposed.
3. Noting areas in which special inspection tooling should be developed to check the product during manufacturing operations.
4. Assuring that specifications and procedures are noted on the drawings and developed to augment information necessary to prove integrity of the item.
5. Determining adequacy and clarity of the documents for interpretation by inspection personnel.
6. Assuring that the product can be inspected.
7. Determining adequacy of the acceptance and test specifications and consistency of the computer program design specifications with software quality requirements.

### 1B302 Change Control

Change control procedures are identified in the ERTS configuration management plan. Quality assurance participates in the change control system by assuring that effectivity points are clearly established and that as built configuration verification inspections are performed in receiving

inspection, sample kitting inspection, fabrication and assembly inspection, fabrication bench test, environmental test, and integration of the system. Configuration status will be documented on appropriate TRW forms and logs.

## CHAPTER 4: IDENTIFICATION AND DATA RETRIEVAL

### 1B400 General

The TRW quality assurance system of identification and data retrieval for hardware was developed in conjunction with the engineering documentation, configuration, and logistics management systems.

The drafting room manual (DRM) outlines the numbering system to be used for engineering drawings, lists of materials, and drawing changes, as well as the system to be used for the numbering of parts, assemblies, and installations. A particular series of drawing numbers issued by Configuration Administration and Data Management (CADM) for the identification of assemblies will be controlled by engineering; physical serialization will be as specified in the ERTS configuration management plan and verified by the applicable quality assurance group.

Quality assurance will be responsible for monitoring the identification of articles and materials received from suppliers. These, as well as in-house manufactured items, will be marked or records maintained to provide clear and adequate identification while in stores and throughout subsequent processing operations.

The identification and data retrieval system for software in support of the ERTS/GDHS operation is discussed in the ERTS configuration management plan.

### 1B401 Identification Methods

Date codes are required only on the unit and components level on articles purchased from suppliers. Lot numbers of articles and materials produced in groups will be identified traceable to the manufacturing job number. This system of serial numbering is defined in the configuration management plan.

During raw material issuance, the lot control numbers are transcribed from the raw material identification label to the applicable production fabrication document. Raw materials that do not reflect a receipt lot control number cannot be used for fabrication in hardware beyond the engineering model phase.

Identification of electrical and electronic parts for flight articles such as semiconductors, resistors, capacitors, diodes, relays, connectors, and transformers will be traceable to the date of manufacture and manufacturer's lot control number. PAR 700-54, subcontractor reliability requirements for ERTS, outlines the requirements for parts selection and control. Traceability for this category of parts to the physical and chemical analysis will not be required. Components for electrical ground support equipment, special purpose test equipment, breadboards, engineering models, and mechanical ground support equipment are exempt except where safety considerations are involved.

#### 1B402 Documentation

Engineering drawing notes define the method and location of hardware identification. TRW process specification PR12-1 defines the acceptable methods of identifying hardware (etching, stamping, ink marking, bag and tag, and nameplates). Specific nameplate requirements will be as specified on engineering drawings.

#### 1B403 Identification Control

Manufacturing personnel document the required configuration and identification on the manufacturing shop orders (MSO) and parts accumulation lists (PAL), and record the as-built configuration and the traceability of material, parts, or units being installed or built into the next higher assembly. Verification of the as-built configuration by inspection is performed on a routine basis and will be documented formally for each end-item. Spacecraft records will reflect its configuration status and verification against configuration management documentation made prior to delivery of configured items.

Serial or lot numbers once assigned are not reassigned to other units or lots. If a serialized item is scrapped, that serial number will not be reassigned to a newly manufactured item.

#### 1B404 Identification List

The controls for the list of materials and parts shall be as defined in the ERTS configuration management plan.

#### 1B405 Retrieval of Records

The configuration management plan defines the system and controls of the configuration status identification list (CSIL) which records as-built versus required design configuration and the associated traceability information. Quality assurance verifies the as-built versus the as-designed configuration anomalies. Detailed records of shop paperwork are filed to permit easy accessibility.

Specific storage and retrieval requirements and responsibilities of the software data center in support of the GDHS will include control of test results data, test materials, and other technical documentation.

## CHAPTER 5: PROCUREMENT CONTROLS

### 1B500 General

TRW quality assurance is responsible for assuring the adequacy and quality of all purchased articles, materials, parts, components, processes, and services. The work task description for procurement/vendor quality assurance is shown in Table 5-1.

### 1B501 Selection of Contractor Procurement Sources

Prior to purchase award, quality assurance will participate in evaluations of proposed major subcontractors/suppliers to ensure the adequacy of their quality systems in meeting project quality requirements. This evaluation is based on review of current supplier quality history, formal supplier quality surveys, and review of suppliers' quality programs and inspection plans submitted on current in-house spacecraft programs.

Proposed subcontractors/suppliers, having demonstrated acceptable quality performance to company requirements, may be used without the performance of supplier surveys. Such subcontractors/suppliers must currently be listed on the quality assurance preferred suppliers directory (QAPSD) and must continue to demonstrate acceptable quality performance to remain on an approved status. When it is economically unfeasible to perform a detailed vendor evaluation for small quantity purchases, standard hardware, or off-the-shelf items, a purchase order will be awarded, provided that the quality of the articles can be adequately verified in TRW receiving inspection or the performance of source inspection.

### 1B502 Procurement Documents

Purchase orders, subcontracts, and associated specifications initiated for the procurement of articles or services will be reviewed by quality assurance prior to release to assure that they include the following requirements.

- Subcontractor/supplier is listed in the quality assurance preferred suppliers' directory.
- Technical data is complete.

Table 5-1. Quality Work Task Description for Procurement/Vendor Quality Assurance

Item Number (Task)	NHB 5300.4 (IB)	QASP (Applicable) Number	SQI (Applicable) Number	Task Description	Requirements for Applicable Type of Hardware					
					Eng Models Fab by Manufacturing	Flight Proto and Qual Hardware	Elect Ground Support Equip	Special Purpose Test Equipment	Mech Ground Support Equipment	GDHS Operational Ground Equipment
1	507	3.0	3.0.1	Quality Assurance Preferred Suppliers Directory. Input data and maintain a quality assurance preferred suppliers directory listing commodity codes, type of survey or evaluation and date, applicable specification approval and limitations, quantity of items inspected, quantity defective, and percent effective.	X	X	X		X	X
2	206 500	3.0	3.0.4	Vendor Quality Requirements Documents. Prepare and maintain project vendor quality assurance document (PAR) for major and critical hardware which define quality assurance provisions to be imposed on a supplier or major contractor as their governing quality specification.	X	X	X	X	X	X
3	502	3.0	3.0.4	Project Procurement Quality Requirements. Prepare and maintain a project/procurement quality requirement document which defines hardware end use, supplier quality assurance system requirements, use of quality assurance preferred suppliers directory, electronic parts matrix usage, hi-rel screening, quality assurance purchase order clause attachments, TRW receiving inspection levels, documentation and test data, so that quality assurance purchase order review personnel assign the appropriate requirements.	X	X	X	X	X	X
4	507	3.0	3.0.1	Supplier History Evaluation. Evaluate and approve procurement sources based on current in-house supplier history records.	X	X	X	X	X	X
5	501	3.0	3.0.1 3.0.3	Survey of New Project Suppliers. Survey and evaluate new or potential project suppliers, complete the supplier evaluation report in accordance with applicable check list to include the following: Management for quality, control of drawings and specifications, control of procurement, government/customer furnished property, control of inspection, measuring, and test equipment, statistical quality control, control of procured supplies and services, handling and storage, fabrication control, completed end-item inspection and test, nonconforming material, product identification, drawing and specification compliance, preservation, packing and shipping, workmanship, special process, retention of inspection and test records, and returned material.	X	X	X	X	X	X
6	202 508	3.0	3.0.1	Technical Assistance to Suppliers. Provide technical assistance and training to suppliers when necessary to achieve desired reliability and quality level. Perform major subcontractor quality requirement orientation as necessary.	X	X	X	X	X	X

Table 5-1. Quality Work Task Description for Procurement/Vendor Quality Assurance (Continued)

Item Number (Task)	NHB 5300.4(1B)	QASP (Applicable) Number	SQI (Applicable) Number	Task Description	Requirements for Applicable Type of Hardware					
					Eng Models Fab by Manufacturing	Flight Proto and Qual Hardware	Elect Ground Support Equip	Special Purpose Test Equipment	Mech Ground Support Equipment	GDHS Operational Ground Equipment
7	500	3.0	3.0.4	Vendor Quality Assurance Plans. Review vendor quality assurance plans as required by the PAR document and resolve plan deficiencies. Review and coordinate vendor request for quote (RFQ) responses for compliance to the imposed quality assurance provisions.	X	X				X
8	510	3.0	3.0.1 15.0.1 15.0.2	Failure and Deficiency Feedback. Conduct failure and deficiency feedback (corrective action to suppliers on deficiencies detected during receiving inspection, test, assembly, integration, and checkout). Utilize TRW formal corrective action system.	X	X	X	X	X	X
9	502	3.0	3.0.2	Procurement Document Review. Review procurement documents to assure and assign appropriate quality clauses and requirements in accordance with the project procurement quality requirements document. Verify supplier status to the QAPSD, special process certification, data package contents, source inspection and acceptance, and need for government source inspection. Verify charges to purchase orders including letters of contract, TWX's, and resolve all anomalies.	X	X	X	X	X	X
10	503 504	4.0	4.0.2	Source Inspection Planning. Prepare source inspection planning for resident and itinerant source personnel. Define the procedures and requirements for in-process inspection, test observation, and final acceptance including associated documentation.	X	X	X	X	X	X
11	505	4.0	4.0.2	Receiving Inspection and Test. Perform receiving inspection tests on parts and components and document the results on incoming supplies to assure conformance to the approval procurement documents, specifications, drawings, and other acceptance criteria. Perform sample inspection in accordance with approved sampling procedures.	X	X	X	X	X	X
12	505 506	4.0	4.0.2	Raw Materials Verification. Verify raw materials and identify by a tag or color coded label denoting physical conditions. Inspect for cracks, seams, and corrosion and perform nondestructive/destructive test and chemical or physical analysis periodically to verify certification reports.	X	X	X	X	X	X
13	505 506	4.0	4.0.2	Limited Shelf Material Verification. Inspect limited shelf material in accordance with special checklists and assure specific storage and temperature conditions are identified with a shelf-life material tag. Assure synthetic rubber items are inspected for cure dates and identify by quarter of year in accordance with tables of age limitations.	X	X	X		X	X

Table 5-1. Quality Work Task Description for Procurement/Vendor Quality Assurance (Continued)

Item Number (Task)	NHB 5300, 4(1B)	QASP (Applicable), Number	SQI (Applicable) Number	Task Description	Requirements for Applicable Type of Hardware					
					Eng Models Fab by Manufacturing	Flight Proto and Qual Hardware	Elect Ground Support Equip	Special Purpose Test Equipment	Mech Ground Support Equipment	GDHS Operational Ground Equipment
14	505	4.0	4.0.6	Receiving Inspection Planning. Prepare receiving inspection planning (and checklists) which describes the type of inspection to be performed (electrical or mechanical), test characteristics, conditions, documentation, and special project instructions.	X	X	X	X	X	X
15	506 801 803	4.0	4.0.2	Documenting Discrepancies. Identify discrep- ant supplies on a nonconforming supplies tag and disposition the items "return to vendor," "rework to specification," or "submit to MRB" in the material adjustment area and document findings.	X	X	X	X	X	X
16	506 507	4.0	4.0.2	Maintenance of Vendor Quality Records. Establish and maintain vendor quality records, field trip reports, discrepancy data, and corrective action commitments.	X	X	X	X	X	X
17	503	4.0	4.0.1	Quality Field Engineers. Assign a major sub- contract and project directed critical hard- ware quality field representative at the vendor's facilities to maintain continuous audits of the vendor's quality system, design, specification, test procedure reviews, first article inspection, traceability, configura- tion verification, test observation, material review board and test review board activi- ties, special process control, and verifica- tion and to assure that quality problems are expeditiously solved.	X	X				X
18	508	16.0	16.0.1	Supplier Audits. Perform periodic supplier audits to assure continued conformance to quality requirements.	X	X	X	X	X	X
19	505	4.0	4.0.6	Hi-Reliability and Magnetic Screening. Pre- pare test procedures, computer data reduc- tion programs, develop inspection test fix- tures, and perform high reliability screening test; or special magnetic screening test on purchased components to verify parameter drift tolerances or magnetic characteristics. X-ray component when required by specification.		X				
20	202 501 508	5.0	5.0.1	Supplier Special Process Certification. Con- duct supplier special process surveys and process certification for magnetic particle inspection, radiograph inspection, penetrant inspection, ultrasonic inspection, contami- nation control and special cleaning, brazing, castings, finishes, fusion welding, resist- ance welding, soldering heat treating, and laboratory testing as applicable.	X	X			X	X
21	505 506 510	4.0	4.0.2	Group A and B Test Data. Review Group A and B test data for conformance to specifica- tion requirements and report all anomalies to the components laboratory.		X				

- Quality assurance provisions are adequately specified.
- Source inspection is specified where required.
- Adequate identification and packaging requirements are specified.
- Identification of product assurance document PAR 700-52, 700-53, or 700-55 as appropriate for project ERTS hardware suppliers and subcontractors (refer to Exhibits 1-2, 1-3, and 1-4).
- Subcontractor requirements for GDHS software are specified in PAR 700-61, Exhibit 1-6.
- Identification to appropriate standard quality program supplier clauses on TRW Form 1991.
- Quality requirements to be imposed on the Form 1991 standard clauses include government source inspection, TRW source inspection, material traceability, special process control, first article inspection, drawings control, configuration management, soldering to NHB 5300.4(3A), failure reports, certification of conformance, physical and chemical test reports, functional test reports/acceptance test data, pressure test certification, radiographic inspection, process certification and control of non-conforming material, and corrective action as applicable.

Note that packaging and handling requirements are identified separately by the packaging and handling personnel in the procurement document review section.

#### 1B503 Contractor Quality Personnel at Source

Source inspection and surveillance will be performed in the following instances:

- When procured articles are required at an advance stage of assembly wherein verification of subcontractor's/supplier's conformance to specification and/or quality requirements cannot readily be assured.
- When special instruments, gages, facilities, and environments are available only at source for verification of test functions or other quality criteria conformance.
- When special processes are involved wherein the quality of the finished article cannot be assured other than by destructive testing.
- When inspection at TRW would involve the uneconomical procurement of additional equipment.

TRW Systems quality representatives will be resident or itinerant at the major subcontractor/supplier facilities. The quality representative will, in conjunction with the supplier, perform the following as appropriate:

- Conduct initial and periodic quality surveys to assure that the supplier maintains a quality system that meets company requirements.
- Conduct a continuous planned review of all phases of the approved quality system to assure compliance. If deficiencies are found, the supplier will be requested to take corrective action.
- Assist the supplier in obtaining interpretation of company quality, drawing, and specification requirements.
- Conduct progressive "first article" inspection and subsequent planned inspection of components, assemblies, and processes as deemed necessary to determine that the products meet the quality and engineering requirements of the purchase order.
- Participate in scheduled design reviews and verify accountability inspection to assure the incorporation of engineering changes, planning changes, and other configuration change commitments.
- Verify test setup compliance to test plans and procedures, witness tests performed, and verify failure reporting and analysis.
- Enter into materials review activities at the supplier's facilities to exercise right of disapproval; assist the supplier in obtaining materials review action on discrepant articles if the supplier has not been delegated materials review authority.
- Coordinate reports of unsatisfactory conditions received on the supplier's articles to ascertain that the supplier establishes the cause of such discrepancies and takes prompt and complete corrective action; assure that the corrective action effectivity points are met and maintained to preclude recurrence.
- Assist the supplier in the implementation of any interchangeability and replaceability program as defined by the purchase order; witness the inspection and check interchangeability verification.

- In some cases, stamp the articles and related paperwork prior to shipment. The supplier will be notified of all such articles requiring this operation by the representative.

In addition to the resident quality representative at the supplier's facilities, quality assurance will provide quality support to various supplier technical areas, such as material and special process control, manufacturing control, workmanship, and quality procedures to assure that quality problems will be expeditiously solved.

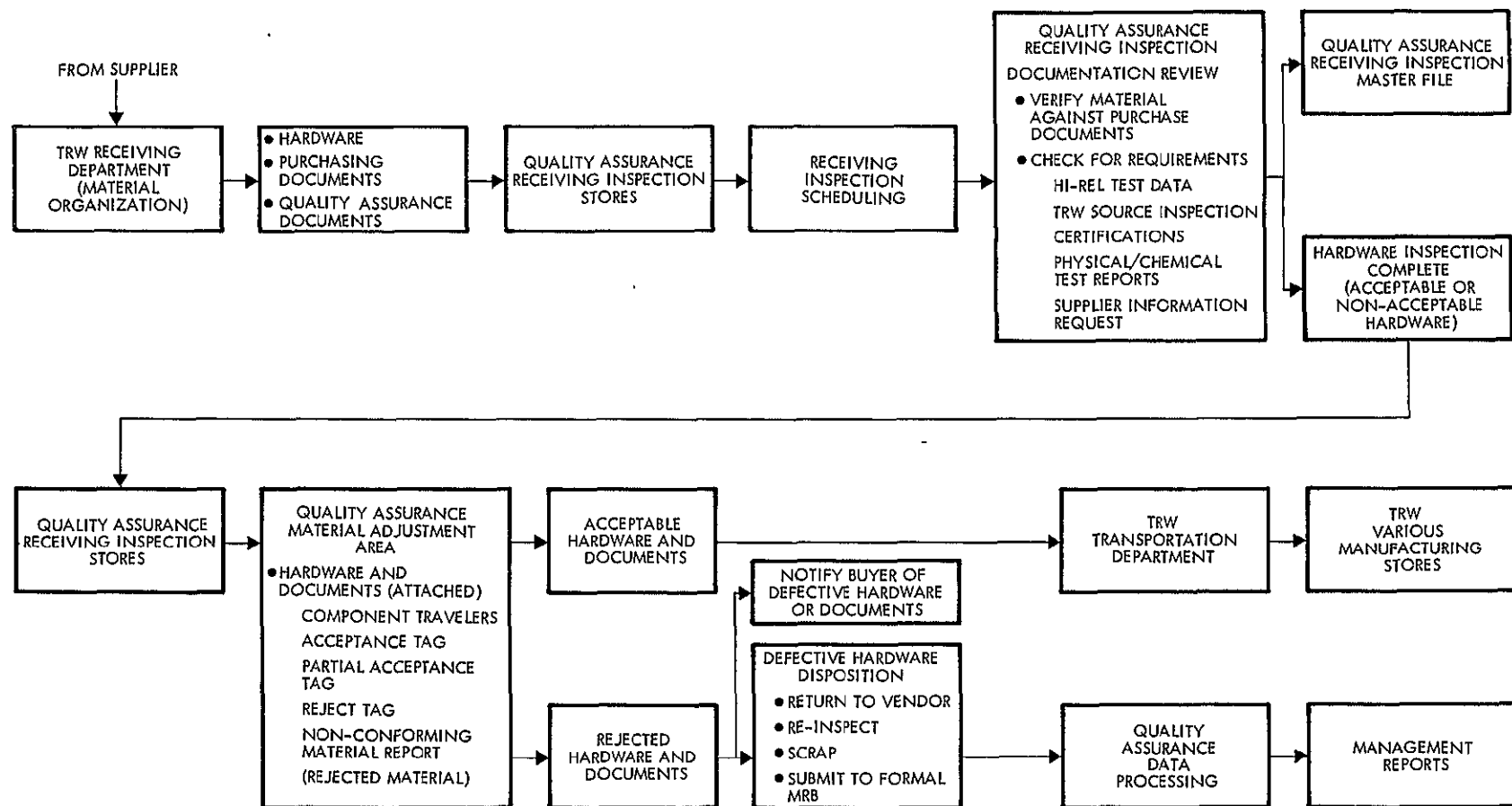
#### 1B504 Government Source Inspection

Items selected by NASA and Defense Contractors Administration Services (DCAS) for the performance of government source inspection will be identified in accordance with Systems Quality Instruction 3.0.4. Imposition of government source inspection (GSI) will not, in any way replace or relieve TRW quality assurance of its responsibility.

#### 1B505 Receiving Inspection

Receiving inspection will be conducted in accordance with company standard flow as depicted in Figure 5-1.

Purchased equipment will be inspected for damage in shipment and for certification, test reports, engineering, or other documentation as specified on the purchase order. Raw materials will be properly identified and composition verification will be performed on a sample basis. Mechanical items will receive inspection with respect to the appropriate blueprint or specifications, with the exception of standard hardware items such as nuts, bolts, screws, and washers which will be inspected on a sample basis. Electronic and electromechanical components will receive functional test for specific parameters. Screening will be in accordance with the requirements defined in the ERTS Reliability Program Plan. Semiconductors and other components requiring high-reliability screening will normally be screened at the supplier's facility and shipped with certified test reports. Complex assemblies, units, or subsystems for which receiving inspection does not have test capability, will be routed to the appropriate area for test under quality assurance surveillance or the test will be witnessed at the supplier's facilities.



MATERIAL RECEIVED AT TRW IS INSPECTED AND DOCUMENTED TO PREDETERMINED REQUIREMENTS. A SYSTEM IS EMPLOYED TO POSITIVELY CONTROL REJECTED MATERIAL.

Figure 5-1  
RECEIVING INSPECTION OPERATIONAL FLOW

Inspection of limited shelf material will be performed in accordance with special checklists. Materials with specific temperature and/or storage conditions are identified with a shelf-life material tag attached to each container.

Synthetic rubber items are inspected for cure dates to assure they fall within age limits. They are identified with cure dates by quarter and year in accordance with tables of age limits.

Storeroom surveillance is performed periodically on a random basis for evidence of inspection and test acceptance, identification, protection, packaging, handling, storage, issuance controls, and general house-keeping cleanliness.

#### 1B506 Receiving Records

Receiving and inspection test records on supplier materials are maintained in the receiving inspection area. Performance Assurance will review supplier test data as described in the Test Monitoring and Control Plan. The results of such inspections and test are available to NASA or its designated agency for review. As appropriate, records for black box buy items are forwarded to the Quality Assurance Test Data Center to become part of the test data package presented to the test review board.

#### 1B507 Supplier Rating System

Quality assurance will maintain a directory of quality assurance preferred suppliers showing current levels of approval and performance status. This directory identifies supplier by name, commodity, and performance appraisal based on supplier-responsible defectives. Data inputs from surveys and audits are coupled with inspection and test results and computer summaries. Reports are published and distributed on a weekly basis to using organizations.

#### 1B508 Postaward Survey of Supplier Operations

TRW will schedule and conduct postaward surveys of suppliers, as necessary, to meet contractual requirements. This survey will include the following: management for quality, control of drawings and specifications, control of procurement, control of government-customer furnished

property, control of inspection, measuring, test equipment, statistical quality control, control of procured supplies and services, handling and storage, fabrication control, completed end-item inspection and test, nonconforming material, product identification, drawing and specification, compliance, preservation, packing, shipping, workmanship, special process, retention of inspection and test records, and returned material.

Supplier quality history evaluations are made on a continuous basis. Problem areas discovered either during the survey or history analysis are documented on appropriate forms and distributed to the supplier for timely correction and prevention of deficiencies. Followup audits and customer interface are performed to assure that corrective actions are implemented.

#### 1B509 Coordination of Contractor-Supplier Inspection and Tests

TRW will coordinate with appropriate suppliers on major and critical items to assure compatibility of supplier inspections and tests with in-house inspections and tests. Quality assurance will provide technical assistance and training to suppliers to achieve desired quality and reliability levels. In addition, selected quality orientations will be performed to suppliers not familiar with quality assurance requirements.

#### 1B510 Nonconformance Information Feedback

Discrepant supplies are reported on nonconforming material reports (NCMR's) and are sent to the material adjustment area for disposition. Material adjustment representation consists of a quality assurance representative, procurement representative, and engineering material review board (MRB) representative.

The nonconforming material reports are dispositioned in the material adjustment area with one of the following dispositions:

- "Return to Vendor" - This disposition is made for items with discrepancies determined to be the supplier's responsibility when such action is consistent with TRW quality schedule requirements.
- "Rework to Specification" - This disposition is made when rework of the item is determined to be feasible and appropriate cost adjustments can be negotiated for supplier responsibility.

- "Submit to MRB" - This disposition is made when it is not feasible to designate a "Return to Vendor" or "Rework to Specification" disposition.

Supplier nonconforming items dispositioned in the material adjustment area are routed as follows:

- Hardware dispositioned "Return to Vendor" is routed to shipping.
- Hardware dispositioned "Rework to Specification" is routed to manufacturing.
- Hardware dispositioned "Submit to MRB" is routed to the material review board (MRB).

TRW assures that supplier takes prompt, remedial, preventive action to preclude recurrence of nonconformances through the utilization of processing formal corrective action requests. These requests are processed through a central corrective action control center.

## CHAPTER 6: FABRICATION CONTROLS

### 1B600 Fabrication Operations

Manufacturing documentation, i. e. , shop order and fabrication/ inspection process procedure, is reviewed by quality assurance planning to assure that the control of hardware is maintained throughout all fabrication, assembly, test, and processing activities. Quality planning verifies that the requirements specified on the planning document are compatible with the engineering documents and that the operational sequences of manufacturing and assembly allow adequate inspection points. The quality work task description for electrical and mechanical planning is described in Table 6-1. Where necessary, special instruction requirements are inserted into the planning documents and special tooling, workmanship standards, and environmental and cleanliness requirements are specified on the manufacturing documentation.

For software operations, a specification of computer programming procedures will provide for test tool applications and will incorporate techniques which will (1) serve as a built-in diagnostic computer program debug aid, (2) provide efficient means for acquiring intermediate test results, and (3) facilitate test plan analysis for completion, redundancy, and validity. Table 6-2 is a quality work task description for software quality engineering and test tools.

### 1B601 Article and Material Controls

Stores inspection is provided to assure that only acceptable parts and materials are admitted into storage. Sample inspection is performed during kitting operations to assure that only approved units of hardware or subassemblies are supplied to the manufacturing line for fabrication or assembly into the next higher assembly levels.

Quality assurance will ensure that special environmental conditions, as specified in the environmental specification required for fabrication and test activities, are complied with.

Table 6-1. Quality Work Task Description for Quality Electrical and Mechanical Planning

Item Number (Task)	NHB 5300.4(1B)	QASP (Applicable) Number	SQI (Applicable) Number	Task Description	Requirements for Applicable Type of Hardware				
					Eng Models Fab by Manufacturing	Flight Proto and Qual Hardware	Elect Ground Support Equip	Special Purpose Test Equipment	Mech Ground Support Equipment
1	300	4.0	4.0.6	Engineering Drawing Release. Review engineering drawing for end-item inspectability and for special inspection tools and gauges prior to release into the manufacturing shop.	X	X	X	X	X
2	600	4.0	4.0.6	Manufacturing Planning Quality Assurance Orientation. Coordinate quality plan requirements with manufacturing planning, hold orientation meetings, and resolve manufacturing/quality assurance requirement conflicts.	X	X	X	X	X
3	600	4.0	4.0.6	Shop Paperwork Review. Review master shop orders and parts assembly lists for completeness and accuracy; determine that the manufacturing operations will produce an acceptable part.	X	X	X		X
4	600	4.0	4.0.6	In-Process and End Item Inspection Points. Coordinate manufacturing shop orders inspection operations with manufacturing planning to assure adequate in-process and end-item inspection points.	X	X	X	X	X
5	102	4.0	4.0.6	Mandatory Inspection Points (MIP's). Verify that mandatory inspection points have been specified on manufacturing shop orders in accordance with project office directives (government/customer mandatory inspection points).		X			
6	600 601	4.0	4.0.6	Acceptance Criteria. Establish the acceptance criteria for manufacturing shop orders inspection operations such as, engineering drawings, process specifications, quality operating instructions, and inspection acceptance tooling.	X	X	X		X
7	400 403	4.0	4.0.6	Configuration and Traceability. Review parts accumulation list for the correct callout of material, components, configuration, and traceability code to preclude use of wrong materials and configurations.	X	X			
8	700	4.0	4.0.6	First Article Inspection. Apply first article inspection requirements to manufacturing shop orders and maintain the associated records as applicable.		X			
9	603	4.0	4.0.6	Raw Materials and In-Process Testing Requests. Prepare laboratory requests for raw material and in-process testing such as, chemical and physical analysis, bonding, thermal, and tensile test as required per military and TRW process specifications. Maintain records of acceptance.	X	X	X		X
10	600	4.0	4.0.6	Planning Changes. Review all planning, in-process manufacturing, and inspection changes to manufacturing shop orders and parts accumulation lists and apply quality assurance approval planning stamp on the associated changed documents.	X	X	X		X

Table 6-1. Quality Work Task Description for Quality Electrical and Mechanical Planning (Continued)

Item Number (Task)	NHB 5300.4(1B)	QASP (Applicable) Number	SQI (Applicable) Number	Task Description	Requirements for Applicable Type of Hardware				
					Eng Models Fab by Manufacturing	Flight Proto and Qual Hardware	Elect Ground Support Equip	Special Purpose Test Equipment	Mech Ground Support Equipment
11	302	4.0	4.0.6	Engineering Change Requests. Initiate and submit engineering change requests as required to correct and/or clarify engineering drawing anomalies. Follow up to assure changes are incorporated.	X	X	X		X
12	400 401 403	4.0	4.0.6	"As Built" Versus "As Designed" Configuration Verification. Review the indentured assembly list of parts/assemblies delivered to integration and compare the "as built" versus the "as designed" condition; resolve configuration differences if they are quality assurance problems.		X			
13	102	4.0	4.0.6	Manufacturing Flow Charts Review. Review manufacturing flow charts if prepared on special items and impose inspection stations in the manufacturing flow (add government/customer mandatory inspection points when required).		X	X		X
14	600	4.0	4.0.6	Support to Engineering and Manufacturing. Perform electrical and mechanical inspection planning services at the request of engineering or manufacturing.	X	X	X	X	X

#### 1B602 Cleanliness Controls

Manufacturing areas requiring environmental controls are monitored to assure that the specific levels remain with acceptable ranges. As a minimum, the environmental criteria established in NHB 5300.4(3A) will prevail in the electrical assembly areas.

#### 1B603 Process Controls

Quality assurance will maintain a defect prevention program for the control of chemical, metallurgical, material cleaning, bonding, welding, coating, plating, and other processes where standard inspection procedures and techniques are inadequate to assure a high quality product. Special processes will be monitored and controlled for uniformity and accuracy and tests will be performed on special process

Table 6-2. Quality Work Task Description for Software Quality Engineering and Test Tools

Item Number (Task)	NHB 5300.4 (1B)	Task Description	Quality Assurance Operational Software Tasks Identified to GDHS Project Phase							
			Milestone "A"	Milestone "B"	Milestone "C"	Milestone "D"	Milestone "E"		Milestone "F"	
							II & T TRW	Conditional Acceptance Test		Final Acceptance and Demonstration
								Tests at TRW	Tests at GSFC	

1	600 601 701	Software Quality Engineering Activities					X	X	X	X
		Quality assurance software engineering support activities to the software quality plan (quality engineering, failure reporting, design reviews, etc.) are required. The task includes the following:								
		<ul style="list-style-type: none"> <li>• Update, and reissue of planning instructions.</li> <li>• Initiate software change requests when software milestone documentation needs clarification or corrections.</li> <li>• Indicate quality status (accepted/rejected) of software computer materials or paperwork.</li> <li>• Verify compliance with configuration and identification requirements.</li> <li>• Witness actual computer runs for compliance with software quality planning.</li> </ul>								
2	600 604	Software Test Tools	X	X	X	X	X	X	X	X
		Software design engineers, programmers, test engineers, and quality engineers will utilize the TRW-developed automated software checkout and evaluation system denoted (PACE), (Exhibit 1-5) Product Assurance Checkout and Evaluation System. Software product assurance tasks are as follows:								
		<ul style="list-style-type: none"> <li>• Adapt and apply PACE to specific needs of ERTS computer operating system and programming language</li> <li>• Establish and carry out training of product assurance, programming, and test engineering personnel in use of PACE</li> <li>• Direct utilization of PACE test tools during installation, integration, and test; review test plan, analyze results of tests and determine test effectiveness; redirect test planning activities as required</li> <li>• Support studies of improved techniques for computer program quality evaluation and reliability assessment</li> </ul>								

solutions to assure conformance to process requirements. Process testing procedures are used to determine the adequacy of process solutions and application. Personnel responsible for special processes will be trained and certified to assure optimum quality and integrity of the product.

Processes to be conducted under special environmental conditions will be monitored by quality assurance to verify the presence of environmental controls. If unsatisfactory conditions occur, immediate corrective action will be implemented prior to continuance of process operations.

Certification of equipment and procedures used in selected process operations will be provided. Recertification will be dependent on quality audits, performance trends, and the modification or incorporation of major changes. The processes requiring equipment certification are welding, radiography, chemical etching, plating, and coating. Personnel will be certified to perform soldering, structural welding, radiography, ultrasonic test, penetrant and magnetic particle inspection, plating and coating, encapsulation, conformal coating, and plastic bonding.

Material and process specifications are prepared by the Materials and Process Engineering Department and are reviewed by quality engineering. These specifications are supplemented by quality assurance operating instructions (QOI's) which specify general and special requirements relative to processed parts inspection. Audits of process applications and operations will be performed over manufacturing processes. Immediate corrective action will be implemented if unsatisfactory conditions occur. In addition, quality engineering will perform various nondestructive and destructive tests to determine the validity of the process operations.

#### 1B604 Workmanship Standards

The TRW process requirements specifications (PR's), quality operating instructions (QOI's), and fabrication/inspection process procedures (FIPP's) support, as required, engineering drawing and specification requirements. Detailed quality inspection instructions

identify the engineering acceptance criteria used in manufacturing and inspection of the hardware. Soldering of spaceborne equipment will be performed in accordance with the ERTS program plan for soldering electrical connections.

Standard software development techniques, where applicable, will be implemented for the ground data handling system.

Software programming standards and conventions implemented on the GDHS during the development phase, are presented in Table 2-6.

## CHAPTER 7: INSPECTIONS AND TESTS

### 1B700 General

In-process inspection and test operations will be established at appropriate intervals during the fabrication and process operations which provide verification of the article's conformance to drawing and specification. Visual aids, inspection checklists, general inspection instructions, and integrated planning documents will be used to effect adequate inspection before the last point at which acceptability or quality may be verified. Test management is effected by the Test Monitoring and Control Plan. Quality assurance participates in the implementation and monitoring of test management requirements as established by the ERTS Project Test Monitoring and Control Plan.

Quality assurance will provide inspection observation of tests conducted on electrical GSE, mechanical GSE, special test equipment, qualification units, and deliverable hardware during manufacturing, environmental, and acceptance test operations. Test observations are performed to assure that the test is conducted in accordance with the governing test procedure, test equipment setup, and calibration requirements. The work task description for inspection and test operations are shown in Table 7-1.

Upon successful completion of acceptance testing, quality assurance personnel will affix flight certification or acceptance stickers to the unit to verify acceptance and prevent test invalidations.

Spacecraft assembly and observatory integration and test operations will be conducted under quality assurance observation. Quality assurance personnel will conduct final visual inspections, configuration verification inspections, and test inspection throughout the integration and test cycle.

### 1B701 Inspection and Test Planning

Quality criteria are made available in advance of inspection needs and issued in the form of written planned inspection sequences, engineering drawings, detailed inspection instructions, and visual aids. Inspection requirements are integrated into manufacturing shop orders by fabrication planning personnel and verified by quality planners for completeness and

Table 7-1. Quality Work Task Description for Inspection and Test Operations

Item Number (Task)	NHB 5300. 4(1B)	QASP (Applicable) Number	SQI (Applicable) Number	Task Description	Requirements for Applicable Type of Hardware					
					Eng Models Fab by Manufacturing	Flight Proto and Qual Hardware	Elect Ground Support Equip	Special Purpose Test Equipment	Mech Ground Support Equipment	GDHS
1	600 700	4.0	4.0.7	Formally-Released Documentation Verification. Verify that manufacturing shop orders, part accumulation lists, engineering drawings, specifications, procedures, and other documents required for inspection purposes have been formally released.	X	X	X			X
2	600	4.0	4.0.7	Mechanical In-Process Inspection Record. Prepare and maintain a mechanical in-process record of the inspection results of kitting, in-process, test, and final operations specified on manufacturing shop orders/part accumulation lists. Record actual dimension of less than 0.0005 tolerances and indicate acceptance or rejection of all other dimensions (mechanical inspection only).	X	X			X	X
3	505 600	4.0	4.0.7	Mechanical Parts Inspection. Inspect parts and subassemblies using precision mechanical inspection tools to the requirements specified on the MSO and engineering drawings consisting of dimensions, special processes, surface finish, workmanship, identification, and packaging (mechanical inspection only).	X	X	X	X	X	X
4	505 600	4.0	4.0.7	Electrical Parts Inspection. Inspect parts, subassemblies, and assemblies using visual and microscopic techniques to the requirements specified on the manufacturing shop orders, engineering drawings, fabrication process procedures, quality operating instructions, visual aids for special processes, workmanship, identification, soldering, bonding, wiring, conformal coating, component mounting, and assembly installations (electrical inspection only).	X	X	X	X		X
5	800 801	4.0	4.0.7	Document Discrepancies. Prepare a discrepancy report (DR) for discrepancies reworkable to specification. Prepare a nonconforming material report (NCMR) for nonconformances and submit for evaluation and the following dispositions: "rework to specification" or "submit to MRB." Describe the anomaly in detail as to drawing section, dimensions, and tolerance callout also stating actual dimensions, special process error, identification, and workmanship anomaly.	X	X	X	X	X	X
6	600	14.1	14.11	Traceability Verification/Kit Inspection. Verify on a sample basis that material and parts kitted per part accumulation lists are traceable to applicable purchase orders, lot control numbers, and fabrication documents per the quality plan.		X				
7	900	4.0	4.0.7	Inspection Tool Calibration. Verify the calibration of inspection tools and equipment used for inspection and acceptance including personal hand tools.	X	X	X	X	X	X

Table 7-1. Quality Work Task Description for Inspection and Test Operations (Continued)

Item Number (Task)	NHB 5300.4(1B)	QASP (Applicable) Number	SQI (Applicable) Number	Task Description	Requirements for Applicable Type of Hardware					
					Eng Models Fab by Manufacturing	Flight Proto and Qual Hardware	Elect Ground Support Equip	Special Purpose Test Equipment	Mech Ground Support Equipment	GDHS
8	403 600 703	4.0	4.0.7	Configuration Verification. Maintain configuration control by verifying that manufacturing shop orders/part accumulation lists specify the latest acceptable review for fabricated and assembled parts.	X	X	X	X	X	X
9	1101	4.0	4.0.7	Packaging and Handling Inspection. Verify that in-process and completed parts are adequately packaged to prevent handling and transportation damage.	X	X				X
10	602	4.0	4.0.7	Cleanliness Conditions. Monitor the fabrication and assembly of parts in a clean room environment for precision mechanical and electrical assembly.	X	X			X	
11	700	4.0	4.0.7	First Article Inspection. Perform first article inspection when specified on manufacturing shop order to determine that the manufacturing technique and engineering design is acceptable. Document and maintain records of the "First Article."		X				X
12	600	4.0	4.0.3	Tooling Inspection. Perform dimensional inspection of fabrication and assembly tools in accordance with tool design requirements (for drill, mill, lathe, weld, alignment, assembly, fixtures, special mandrels, templates, and general mechanical aerospace ground equipment, welding slings, hoists, holding fixtures, and dollies (mechanical inspection only).	X	X			X	X
13	600 601	4.0	4.0.4	Tool Proofing. Determine by tool proofing that tools which are dimensionally acceptable are capable of producing parts meeting engineering drawing requirements.	X	X				X
14	600 601	4.0	4.0.4	Tooling Reinspection. Reinspect tools periodically for wear at critical points and for visual damage.	X	X				X
15	600 603	4.0 5.0	4.0.2 5.0.1	Nondestructive Testing. Perform nondestructive testing using penetrant, ultrasonic, radiographic, magnetic particle, eddy current, videgage, dermitron, and microscopic methods (mechanical/NDT inspection only).	X	X			X	
16	600 603	5.0	5.0.1	Weld Schedules and Specimen Testing. Participate in establishing weld schedules for spot ultrasonic weld machines by performing specimen inspection testing.	X	X	X	X	X	
17	600 705 707	4.0	4.0.8	Acceptance Bench Test Observation. Observe the electrical acceptance bench test operations and verify that the test is performed in accordance with test procedure requirements of data acquisition. Quality assurance observation personnel will review completed test data and verify the acceptance by stamping the paragraphs witnessed (fabrication acceptance test inspection only).	X	X	X			X

Table 7-1. Quality Work Task Description for Inspection and Test Operations (Continued)

Item Number (Task)	NHB 5300.4(1B)	QASP (Applicable) Number	SQI (Applicable) Number	Task Description	Requirements for Applicable Type of Hardware					
					Eng Models Fab by Manufacturing	Flight Proto and Qual Hardware	Elect Ground Support Equip	Special Purpose Test Equipment	Mech Ground Support Equipment	GDHS
18	102 703	4.0	4.0.8	Mandatory Inspection Points. Notify cognizant customer/government representative of mandatory in-process inspection test points prior to the start of testing and document the notification on the manufacturing shop order.		X				X
19	600 707	8.0	8.0.1	Indication of Inspection Status. Perform final inspection, configuration verification, and document review. Indicate inspection status by applying appropriate inspection stamp to hardware and documentation as applicable to end-item use.	X	X	X	X	X	X
20	600 707	4.0	4.0.3	Support to Engineering and Manufacturing. Perform electrical and mechanical inspection services at the request of engineering and manufacturing to meet end-item needs.				X		X
21	600 1100 1101	12.0	12.0.1	Storeroom Inspection. Perform storeroom inspection to verify proper control, to include storage, packaging, handling, limited shelf life, rubber cure dates, material issuance, and associated documentation.	X	X	X		X	X
22	as above	as above		Integration Returns Quality Inspection. Perform a visual inspection on returning hardware, inspect the rework of discrepancies, and observe the fabrication acceptance test and document as required in accordance with the complete work task description for nondestructive test inspection, electrical inspection, mechanical inspection, and fabrication acceptance test observation.		X	X		X	X

acceptability of the inspection points and proper instruction call outs. The characteristics to be observed are specified for each predetermined examination point, including tolerance limits and special conditions under which inspection is to be performed. A typical black box inspection flow chart is shown in Figure 7-1.

Special manufacturing/inspection flow charts for component modules and subsystems are prepared by manufacturing with inputs from quality assurance on specific items for planning purposes. These charts

contain the fabrication, inspection, and test operations performed during the fabrication and assembly cycles. The inspection and tests performed are conducted with the use of specific procedures, such as quality operating instructions, visual aids, special checklists, test procedures, and test data sheets, each containing accept/reject criteria in accordance with the specifications.

Table 7-2 describes a work task description for software test planning and testing.

Software inspection and test procedures are outlined early in the software preparation activity. Use of standard programming conventions and approved methodology during the coding phase enhances application of the Product Assurance Checkout and Evaluation (PACE) System test tools. The PACE automated software quality assurance tools aid in a cost-effective testing program for determination of computer program quality. Exhibit 1-5 provides a brief description of PACE, and an attachment which illustrates the basic operation of the FLOW computer program, an element of the PACE system.

#### 1B702 Test Specifications

The requirements of test objectives, reliability goals, test parameters and tolerances, and environmental conditions will be specified in the equipment or subsystem specification. Test procedures utilized during checkout incorporate engineering requirements specified in the "D" or equipment specifications. Quality assurance reviews these specifications and provides technical and quality inputs.

#### 1B703 Inspection and Test Procedures

Quality inspection will inspect in-process testing operations to controlled test procedures. Quality assurance reviews the procedures and provides technical and quality inputs.

#### 1B704 End-Item Inspection, Test Specifications, and Procedures

Test procedures for the end-item unit and system level test will be prepared and testing will be performed to these released test procedures under quality inspection observation. Quality assurance reviews the procedures and provides quality and technical inputs.

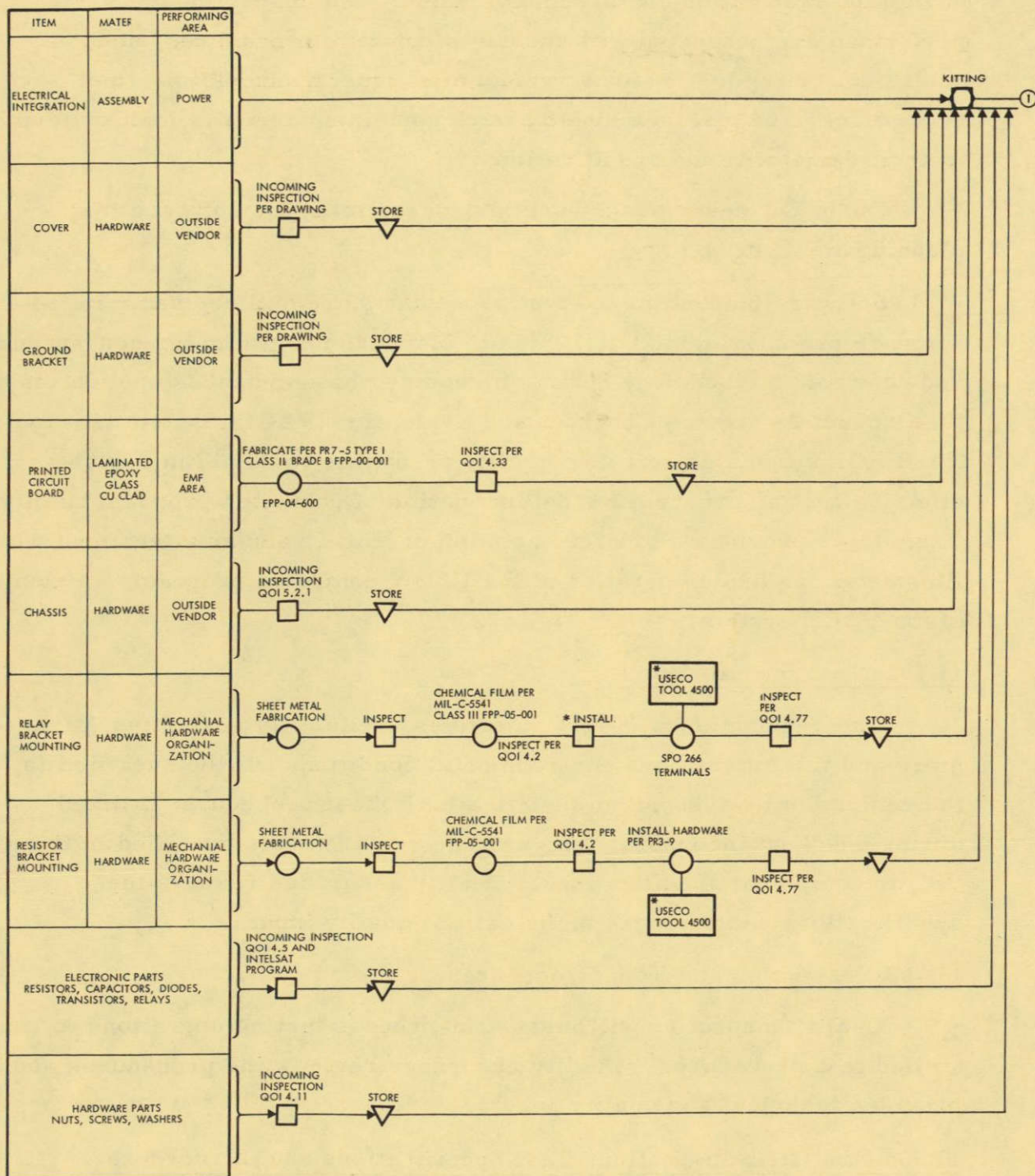


Figure 7-1

INSPECTION AND TEST FLOW DIAGRAM showing quality assurance tasks to be performed on a black box proposed for this project

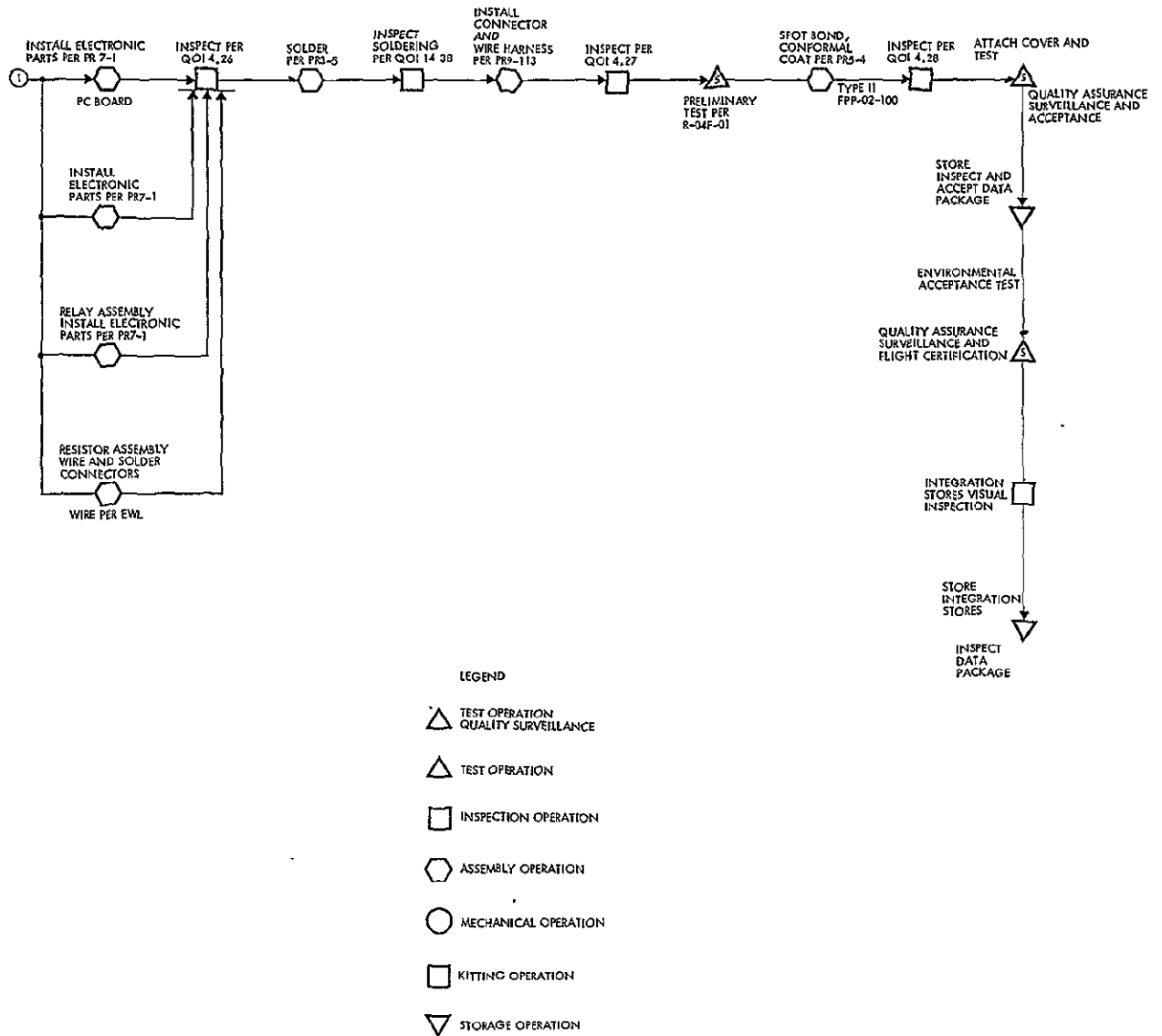


Figure 7-1

INSPECTION AND TEST FLOW DIAGRAM showing quality assurance tasks to be performed on a black box proposed for this project (Continued)

## 1B705 Inspection and Test Performance

Assemblies constituting deliverable end items will be final acceptance-tested according to approved acceptance test procedures. Tests and inspections will be accomplished in a manner that will not result in degradation or deterioration of the item. The quality work task description for environmental test inspection operations is described in Table 7-3.

Table 7-2. Quality Work Task Description for Test Planning and Software Testing

Item Number (Task)	NHB 5300, 4 (IB)	Task Description	Quality Assurance Operational Software Tasks Identified to GDHS Project Phase						
			Milestone A	Milestone B	Milestone C	Milestone D	Milestone E		Milestone F
							II & T TRW	Conditional Acceptance Test	Final Acceptance and Demonstration
							Tests at TRW	Tests at GSFC	

1	700	Software Test Planning				X	X	X	X	X
	701	Quality assurance personnel, in conjunction with the integration and test group, will perform the following functions:								
	703									
		<ul style="list-style-type: none"> <li>Participate in the planning and scheduling of test events</li> <li>Determine conformance to software quality test plan. Provide to programmers, test engineers, and others an evaluation of conformance to quality requirements</li> <li>Review and approve test procedures to ensure the adequacy of the quality and test data requirements. Provide the criteria necessary to verify conformance to these requirements. Develop appropriate quality review checklists and ensure that test procedures do not go through the system "open loop." Approve software subsystem and system level, acceptance, and systems test procedures</li> <li>Review executed test data for verification of data to procedure parameters prior to continuance with other scheduled tests. This includes clearing discrepancies encountered during testing, open failure reports, and incorporation of change notices</li> <li>Verify that the interfaces between the modules and functions appear to be properly designed and free of coding errors</li> <li>Ensure that all functions of each element have been included and properly implemented</li> <li>Ensure that all interfaces with hardware are free of incompatibilities</li> <li>Ensure that timing and throughput meet the system expectations</li> <li>Ensure that simulated hardware and software properly represent the actual environment.</li> </ul>								

Table 7-2. Quality Work Task Description for Test Planning and Software Testing (Continued)

Item Number (Task)	NHB 5300.4 (1B)	Task Description	Quality Assurance Operational Software Tasks Identified to GDHS Project Phase							
			Milestone A	Milestone B	Milestone C	Milestone D	Milestone E		Milestone F	
							II & T TRW	Conditional Acceptance Test		Final Acceptance and Demonstration
								Tests at TRW	Tests at GSFC	

2

Software Testing:

705	Inspection and Test Performance						X	X	X	X
	<ul style="list-style-type: none"> <li>• Ensure that the total testing has been accomplished as stated in test plans</li> <li>• Monitor all failure reports</li> <li>• Monitor all change notices</li> <li>• Compile test data</li> <li>• Verify that all changes have been incorporated</li> <li>• Ensure that corrected programs have been re-run and validated for expected outputs</li> <li>• Make recommendations for future computer program modifications</li> <li>• Make recommendations for approvals or deferrals of requirements and design features.</li> </ul>									

Table 7-3. Quality Work Task Description for Environmental/Test Observation

Item Number (Task)	NHB 5300.4(1B)	QASP (Applicable) Number	SQI (Applicable) Number	Task Description	Requirements for Applicable Type of Software				
					Eng Models Fab by Manufacturing	Flight Proto and Qual Hardware	Elect Ground Support Equip	Special Purpose Test Equipment	Mech Ground Support Equipment
1	700 703 705 707	4.0	4.0.8	Fabrication Bench Test Data Review. Review data package for evidence of fabrication inspection and acceptance prior to environmental acceptance or qualification testing. Quality assurance monitors acceptance testing to ensure that tests are conducted in accordance with approved test procedures and to provide measure of conformance without degradation of quality or deterioration of the item tested.		X			
2	705 707	4.0	4.0.8	Inspection Prior to Test. Inspect items submitted for damage, proper identification and review routing, and operations record for authorization of test.		X	X		
3	705 707	4.0	4.0.8	Documentation and Procedure Verification. Verify through CADM as applicable correct revision letter of test procedure prior to commencing test. On rework returns for environmental retest, verify acceptance of rework on original discrepancy report, assure that authorized retest instructions are entered in rework instructions section and concurred by cognizant project quality engineer. Log test to be performed in the squawk report and test observation log.		X	X	X	X
4	707	4.0	4.0.8	Equipment Set Up and Calibration. Verify test equipment setup and proper calibration of equipment and associated test tooling or support equipment (i. e., vibration and thermal vacuum shock fixtures).		X	X	X	X
5	705 707	4.0	4.0.8	Acceptance and Qualification Test Observation. Observe the acceptance or qualification test operations and verify that the test is performed in accordance with test procedure requirements of data acquisition. Quality assurance observation personnel will review all completed test data and verify acceptance by stamping paragraphs witnessed.		X	X		X
6	706 707	4.0 9.0	4.0.8 9.0.3	Test History Records. Initiate a test discrepancy report when test results exceed test procedure limits and notify quality engineer after engineering disposition. Ensure that all pertinent IOC's, TCR's, PCN's, PCO's, DR's, NCMR's, SCN's are entered adjacent to affected paragraph in squawk log and entered on routing and operations record. Identify and stamp all other additional data obtained by chart records.		X	X	X	X
7	707	9.0	9.0.3	Submittal of Nonconforming Test Discrepancies to Material Review Board. If necessary, transfer test discrepancy report to nonconforming material report, identify discrepant unit, and submit to board for further action and disposition.		X			

**Table 7-3. Quality Work Task Description for Environmental/Test Observation (Continued)**

Item Number (Task)	NHB 5300.4(1B)	QASP (Applicable) Number	SQI (Applicable) Number	Task Description	Requirements for Applicable Type of Hardware				
					Eng Models Fab by Manufacturing	Flight Proto and Qual Hardware	Elect Ground Support Equip	Special Purpose Test Equipment	Mech Ground Support Equipment
8	706 707	4.0	4 0 8	Flight Certification or Acceptance Identification. Upon completion of each test required on routing and operation record and after verification of necessary documentation is completed, data package should be submitted for final review and configuration check at data center, apply flight certified or acceptance tag and label to the unit upon acceptance of the completed data package.		X			
9	706 707	14.0	14.01	Quality Test Data Packages. Assist quality data center, in review and preparation of data prior to submitting to the test review board. Coordinate anomalies with test personnel and obtain approval copies of test change records, procedure change notices, and specification observation notices.		X			
10	102 701	4.0	4.0 8	Mandatory In-Process Inspection Test Points. Notify cognizant customer/government representative of mandatory in-process inspection test points prior to the start of testing and document the notification in the test log.		X	X		X

Detection of unusual or questionable occurrences during final fabrication inspection and test of end items will be documented on appropriate quality forms. Quality data reflecting results of final tests conducted on end items will be maintained on file.

Inspection and test data packages will be maintained for black boxes. The data will be accumulated until the final unit test, then collated into a final test data package, and maintained on file in the quality assurance data files.

Rework, modification, repairs, or replacements conducted on end items after or during final test will require such items to be resubmitted for inspection or test as applicable.

Before observatory integration, quality assurance accumulates and reviews (as part of the test review board) quality assurance test data packages. Acceptance hardware is placed in controlled storage until required for assembly and integration operations. Certification or acceptance seals are affixed so that opening the unit destroys the seal and, therefore, voids the flight certification.

Inspection of qualification test operations is performed by quality assurance personnel to verify that design requirements are achieved in environments established by the specification. Requalification testing will be performed when determined that significant design, process, procurement, or fabrication operations have taken place invalidating previous qualification status. Recommendations for requalification testing are made by the responsible engineering group with the concurrence of the ERTS project performance/assurance manager. TRW will substantiate qualification of items based on similarity by thorough engineering evaluation of design and qualification test requirements.

Quality assurance support of the observatory integration and test operation is described in the work task description (see Table 7-4). System discrepancies, deviations, or anomalies will be noted in the observatory inspection squawk log. A systems level daily narrative log book will be maintained for each system entering integration wherein all activities performed on the system will be logged in chronological order each day. Quality personnel will verify installations, harness routing, torquing, and assembly operations to appropriate drawing and/or procedures. Records of all installations, mating and demating of connectors, acceptances, and removal of hardware will be recorded. Quality inspection will observe data acquisition and maintain a controlled record copy of test and integration data generated throughout the test integration and test cycle. Test data will be presented to the test review board for formal approval. An end-item inspection and test report will be prepared concurrent with delivery of the ERTS observatory and transmitted to NASA/GSFC in accordance with contracted requirements.

Table 7-4. Quality Work Task Description for Observatory, Integration and Test Inspection Observation

Item Number (Task)	NEB 5300.4(1B)	QASP (Applicable) Number	SQI (Applicable) Number	Task Description	Requirements for Applicable Type of Hardware				
					Eng Models Fab by Manufacturing	Flight Proto and Qual Hardware	Elect Ground Support Equip	Special Purpose Test Equipment	Mech Ground Support Equipment
1	203 706	4.0 14.0	4.0.9 14.0.1	Spacecraft Log Book. Establish and maintain a log book system for each spacecraft/system representing complete spacecraft activities. The log book system will contain a narrative log, break of inspection, squawk report, test record sheet, assembly installation and inspection log, nonconforming material report, failure report, discrepancy report, operating time records, routing and operations forms, and acceptance data.		X	X		
2	203 706	4.0	4.0.9	Record of Spacecraft Events. Record events such as discrepancies, removals and replacements of hardware, work accomplished, test results, special instructions, and customer notification for mandatory inspection points in the spacecraft log books.		X	X		
3	705 707	4.0	4.0.8	Inspection Verification of Flight Hardware. Verify previous inspection acceptance of all flight hardware received in the area for incorporation in the spacecraft/system to verify flight certification, proper documentation, and damage during handling.		X			
4	706 707	4.0	4.0.8	Discrepancy Identification and Documentation. List discrepant or damaged items discovered during inspection on a squawk report and record in the spacecraft log book, document item(s) which are removed from the spacecraft/system on a discrepancy report to assure nonconforming items control.		X	X		
5	705 707	4.0	4.0.8	Integration and Test Observation. Observe hardware installation, integration, and test operations to assure conformance to approved procedures. Monitor integration and test area for cleanliness, potential hazard, and general handling procedures. Verify items such as torquing, alignment, bonding, and workmanship.		X	X		
6	706 707	14.0	14.0.1	Test Anomaly Documentation. Document test anomalies on the test discrepancy report and test record sheet and prepare NCMR's as required to provide information for corrective action and total historical record.		X	X		
7	707	18.0	18.0.1	Spacecraft Configuration Verification. Verify spacecraft configuration prior to major milestone test, i. e., integrated system test, vibration, and thermal vacuum testing, and publish spacecraft configuration status prior to major milestone testing.		X	X		

Table 7-4. Quality Work Task Description for Observatory, Integration and Test Inspection Observation (Continued)

Item Number (Task)	NHB 5300.4(1B)	QASP (Applicable) Number	SQI (Applicable) Number	Task Description	Requirements for Applicable Type of Hardware				
					Eng Models Fab by Manufacturing	Flight Proto and Qual Hardware	Elect Ground Support Equip	Special Purpose Test Equipment	Mech Ground Support Equipment
8	707	4.0	4.0.9	Test Data Verification. Review executed test data for verification of test data to test procedure parameters prior to continuance with other scheduled tests, including clearing discrepancies encountered during testing, open NCMR's, failure reports, and incorporation of outstanding engineering orders.		X			
9	707	4.0	4.0.4	Open Squawk Record Resolution. Conduct weekly squawk review of spacecraft status. Review with the test conductors and appropriate personnel, discrepancies logged against the spacecraft/ system and issue action items to resolve problem areas and corrective action against those items which are recurring.		X			
10	707	18.0		Configuration and Item Verification. Conduct configuration inspection prior to initial integrated system test (IST). Coordinate configuration inspection performed by an engineering team from the following areas: configuration management office, quality assurance, integration planning and logistics, test director's office, and the test conductor. Log and document anomalies and maintain a closeout of action items.		X			

Quality assurance uses established procedures for control of end articles of equipment from receipt of equipment at installation locations; during installation of equipment; and through checkout, launch, and postlaunch operations. Applicable quality documentation for use at the launch site must be reviewed and/or approved by the project quality manager or his designated representative before implementation. Secured bonded areas at the launch site will be established under quality assurance cognizance.

A quality assurance team, directed by the launch manager and consisting of appropriate quality engineering, inspection, and calibration personnel will be assigned to each launch operation. Work task description for quality assurance launch activities are shown in Table 7-5. The inspection personnel on the quality assurance team will perform observation of off-loading and transportation operations connected with receipt and shipment. Quality personnel will monitor the quality requirements of prelaunch and launch operations, including the return of residual equipment.

The quality engineer responsible for launch support ensures that launch operations are performed in accordance with quality assurance procedures and are appropriately documented. His responsibilities include:

- Develop quality assurance launch procedures to ensure that the quality and configuration requirements are adhered to and documented
- Maintain liaison with site quality control representatives to ensure compliance with site quality assurance requirements
- Keep the launch manager informed of requirements, problems, and potential problems and advise on solutions
- Maintain daily quality control logs to serve as objective evidence and chronological history of work accomplished
- Ensure that bonded storage is maintained in accordance with applicable procedures
- Ensure that red tag items "remove before flight" repository are kept under bonded conditions to serve as objective evidence that items were removed prior to flight
- Ensure that shipping and receiving inspection (at launch site) is performed in accordance with applicable procedures
- Serve as a member of the flight readiness and/or test review board as required
- Provide administrative support for quality assurance personnel assigned to the launch team
- Participate in launch recycle decisions as required; provide equipment failure report data and maintain current time logs on flight equipment as required

Table 7-5. Quality Work Task Description for Quality Assurance Launch Activities

Item Number (Task)	Divisional Management Policy	NHB 5300.4(1B)	QASP - Applicable Number	SQI - Applicable Number	Task Description	Quality Assurance Launch Task Identified to Project Phase						
						Preproposal and Proposal Phase	Contract Go-Ahead Phase	Procurement Phase	Design Development Phase	Fab Integration and Test Phase	Shipment and Launch Phase	GDHS Operations
1	X	206	17.0		Quality Assurance Launch Activities Plan. Prepare a quality assurance launch activities plan that provides for packaging, storage, shipping, receiving inspection, bonding stores, integration and checkout, test equipment, metrology, and site deactivation (project quality engineering).					X		X
2	X	200 201	17.0		Launch Team Activation. Select a quality assurance launch team and train for launch duties. Perform launch activities scenarios to assure a well-planned quality assurance launch routine (project quality engineering).					X		X
3	X		17.0		Test Range Evaluation. Survey and evaluate test range (field site) for the handling of metrology, propellants and fuels, storage facilities, and associated quality assurance support organizations.					X		X
4		1100 1101 1102	12.0	12.0.1	Packaging/Shipping/Storage Procedures. Review packaging, shipping and storage procedures for the spacecraft/GDHS associated test equipment, spares, and documentation.					X		X
5		700	12.0 4.0	12.0.1 4.0.11	Packaging and Shipping Inspection. Inspect the packaging and handling of spacecraft/GDHS and spares activities in accordance with approved procedures. Verify that associated documentation, microfilm data packages, and inspection and measuring tools have been included.						X	X
6		206 706	4.0 17.0	4.0.2	Receiving Inspection at Launch/Field Site. Conduct receiving inspection at launch site verifying documentation, data packages, hardware conditions, damage or deterioration, and storage of spacecraft/GDHS, spares, mechanical AGE, electrical AGE, and support equipment.						X	X
7	X	200 206	12.0	12.0.1	Bonded Stores Control. Verify that items have been placed in a "bonded stores" and that strict adherence to procedures are followed for requisitioning spares and equipment from stores.						X	X

Table 7-5. Quality Work Task Description for Quality Assurance Launch Activities (Continued)

Item Number (Task)	Divisional Management Policy	NHB 5300.4(1B)	QASP - Applicable Number	SQI - Applicable Number	Task Description	Quality Assurance Launch Task Identified to Project Phase						
						Preproposal and Proposal Phase	Contract Go-Ahead Phase	Procurement Phase	Design Development Phase	Fab Integration and Test Phase	Shipment and Launch Phase	GDHS Operations
8	X	900	17.0	2.0.2	Metrology. Verify that the calibration of all measuring and test equipment used for integration and checkout of the spacecraft and systems and the support equipment will extend through the launch cycle. Coordinate with site metrology personnel for special purpose calibrations.						X	X
		905	2.0	2.0.3								
9		707	17.0 4.0	4.0.9	Integration and Test Observation. Maintain a daily narrative log, chronological history record of work accomplished, and a running-item log for all spacecraft/GDHS activities. Perform inspection verification of all integrated activities and test observation of all tests in accordance with approved test procedures.						X	X
10		706	4.0	4.0.2	Document Discrepancies. Prepare a discrepancy report for discrepancies reworkable to specification, prepare a nonconforming material report for nonconformances, and submit to the material review board for evaluation. Prepare a failure report for failed items and submit to the launch failure review board.						X	X
		707	9.0	4.0.7								
				9.0.3								
				9.0.5								
11	X		17.0		Flight/GDHS Readiness Review Board. Participate as a member of the flight readiness review board reviewing launch integration and test data. Perform final acceptance of the payload integration.						X	X
12	X		4.0	4.0.11	Site Deactivation. After launch, verify the packaging, storage, and shipment of spares, MAGE, and associated test equipment in accordance with the post-launch quality checklist. Verify that items and documentation are properly accounted for.						X	X
			17.0 12.0	12.0.1								

- Advise launch manager of quality assurance facilities requirements during the planning stages of launch support
- Develop a specific material review system for discrepant material at the launch site.

For ground support equipment, the following quality assurance requirements will be established to assure compliance with contractual requirements:

- Inspection to a released top assembly drawing prior to closure
- Inspection to schematic drawings with identifying part symbols
- Parts lists
- Fabrication utilizing soldering personnel certified to the requirements specified in the ERTS program plan for soldered electrical connections
- Calibration performed to written procedure
- Functional and capability validation including continuity checking performed to written procedure.

#### 1B706 Inspection, Test Records, and Data

Lower level fabrication and assembly history, build-up and dis-assembly repairs, rework, and modifications are maintained in manufacturing/inspection files. The end-item data package will contain the top manufacturing shop order. Detailed information can be traced to the lower level assembly buildup. TRW maintains a separate manufacturing/inspection file for all groupings of fabrication and sub-assembly and a separate unit-type file for end item. Nonconforming material reports and material review board (MRB) actions are filed in the board's center. The manufacturing shop orders contain reference to nonconforming material reports and, therefore, detailed information can be traced from it to a corresponding nonconforming material report.

Quality test data packages for unit level tests and spacecraft integration tests are maintained in the quality assurance test data center.

Table 7-6. Quality Work Task Description for Quality Assurance  
Test Data Center

Item Number (Task)	NHB 5300.4(1B)	QASP (Applicable) Number	SQI (Applicable) Number	Task Description	Requirements for Applicable Type of Hardware					
					Eng Models Fab by Manufacturing	Flight, Proto and Qual Hardware	Elect Ground Support Equip	Special Purpose Test Equipment	Mech Ground Support Equipment	GDHS Equipment
1 203 706	14.0	14.0.1		Test Data Receipts in Test Data Center. Review formal copies of test data submitted to the quality assurance data center and verify the acceptance and completion of processed data. Enter received data in the "test data log," record status, catalog contents of the data, and retain in files.		X				X
2 203 706	14.0	14.0.1		Test Data Package Preparation. Assemble test data into a test data package as directed by the project quality manager. Collate the test data package sequentially according to the routing and operations sheet. Prepare separate tab dividers and separate items by test procedure and test data. Prepare table of contents and a test data package sign-off sheet.		X				X
3 203 706	14.0	14.0.1		Data Package Records Accumulation. Reproduce squawk reports, discrepancy reports, non-conforming material reports, test change records, parts change notices, procedure change orders, failure reports, associated correspondence, and configured indentured parts listings as applicable; add to the total data package making a complete history of the test and associated documents.		X				X
4 203 706	14.0	14.0.1		Test Data Package Review. Review test data packages in accordance with the test data package checklist assuring that configuration test data and associated documentation are complete. Coordinate with integration and test personnel to resolve test data anomalies.		X				X
5 203 706	14.0	14.0.1		Submittal for Test Review Board. Supply test data packages to the project quality manager or his designee for presentation to the test review board and customer for acceptance. Upon review and acceptance of the test data package, coordinate all "open action items" and perform final review and acceptance if anomalies exist during the test review board.		X				X
6 203 706	14.0	14.0.1		Microfilm and Storage Test Data Packages. Number each page in the test data package sequentially, prepare microfilm transmittal, and ship data packages to configuration administration then data management for the preparation of microfilm aperture cards. Maintain microfilm aperture cards in data center and after launch, forward test data packages to the TRW records retention center.		X				X

Its work task description is described in Table 7-6. Quality assurance assigns an inspection crew to the observatory for the period of integration, test, and launch. This crew verifies and documents installations, removals, alterations, and tests of any kind performed on the observatory. Quality assurance initiates and maintains a log book in which the history and configuration of the observatory is documented. It includes the following: break of inspection, chronological test record, running time log, assembly squawk record, test discrepancy, narrative log, spacecraft nonconforming material reports, test procedures, test record sheets, limited life records, and an assembly installation and inspection log.

The software test data center is established to log and store all computer related test data generated. The work task description for this function is provided in Table 7-7.

#### 1B707 Contractor Quality Assurance Actions

Quality assurance inspection of acceptance testing verifies that all tests are conducted in accordance with approved test procedures and provides a valid measure of conformance.

Quality inspection personnel verify test setup, test equipment utilization and calibration, hardware acceptability for test, and correct configuration, and assure accurate documentation in data recording and test anomalies.

During testing, quality assurance inspection personnel will inspect the test operation (1) to ensure that testing is accomplished in accordance with approved formal test procedures, and (2) to ensure the accuracy and completeness of records of test results, document rework, repair, modification, removal, and replacements during the test operation, and document nonconformances. Subsequent to test completion, quality inspection personnel review all documentation, flight certify the unit, and submit the data package to the test review board when all dispositions and "open squawks" have been resolved.

Quality assurance personnel will be responsible for the verification and preparation of software computer materials and reports at formal testing phases. This task will be undertaken to ensure that the required and approved materials are available, that all changes initiated during runs

are documented, and that tests are verified in accordance with test procedures and specifications.

For detail task descriptions, see Table 7-8.

Table 7-7. Quality Work Task Description for Quality Assurance Software Data Center

Item Number (Task)	NHB 5300.4 (1B)	Task Description	Quality Assurance Operational Software Tasks Identified to GDHS Project Phase							
			Milestone A	Milestone B	Milestone C	Milestone D	Milestone E		Milestone F	
							II & T TRW	Conditional Acceptance Test		Final Acceptance and Demonstration
								Tests at TRW	Tests at GSFC	
1	203 706	<p>Software Test Documentation</p> <p>The data contained within the center will be used by test and configuration control personnel to document changes to the software while maintaining exact records of the software at any given time.</p> <p>The test center will make available to all ERTS project personnel the following data</p> <p>Data generated prior to test:</p> <ul style="list-style-type: none"><li>• Test plan</li><li>• Test procedures</li><li>• Test logs</li><li>• Configuration control change list</li><li>• Allocated computer run time and location</li></ul> <p>Data generated during test:</p> <ul style="list-style-type: none"><li>• Quality assurance history log</li><li>• Failure reports</li><li>• Discrepancy reports</li><li>• On-the-spot change data and material</li><li>• Test verification inputs</li><li>• Output Listings</li><li>• Software problem report (SPR)</li><li>• Program change record (PCR)</li></ul>	X	X	X	X	X			
2	203 706	<p>Test Data Center personnel will:</p> <ul style="list-style-type: none"><li>• Collect, review, and assembly into a data package the completed acceptance test data and other applicable documentation</li></ul>	X	X	X	X	X			

Table 7-7. Quality Work Task Description for Quality Assurance Software Data Center (Continued)

Item Number (Task)	NHB 5300.4 (1B)	Task Description	Quality Assurance Operational Software Tasks Identified to GDHS Project Phase							
			Milestone A	Milestone B	Milestone C	Milestone D	Milestone E		Milestone F	
							II & T TRW	Conditional Acceptance Test		Final Acceptance and Demonstration
								Tests at TRW	Tests at GSFC	

- Coordinate and distribute data packages which consist of computerized reports derived from inspection and test logs, containing acceptance, rejection-correction-retest records, operating time, and other relevant quality status records
- Complete the software computer program package by serial number units, and, where appropriate, forward to the next site participating in the test cycle
- Arrange for reproduction of required copies.

Table 7-8. Quality Work Task Description for Verification and Preparation of Computer Test Operations Material

Item Number (Task)	NHB 5300.4 (1B)	Task Description	Quality Assurance Operational Software Tasks Identified to GDHS Project Phase							
			Milestone A	Milestone B	Milestone C	Milestone D	Milestone E		Milestone F	
							II & T TRW	Conditional Acceptance Test		Final Acceptance and Demonstration
								Tests at TRW	Tests at GSFC	
1	405	Computer Test Operations					X	X	X	X
	700									
	701	The specific tasks to be undertaken are:								
	706									
	707	<ul style="list-style-type: none"><li>• Verify compliance with configuration control change lists supplied by configuration management</li><li>• Verify that all run materials* are assembled before specified acceptance runs are initiated</li><li>• Prepare quality assurance history run log</li><li>• Assemble and package all failure and discrepancy reports generated during run and ensure proper distribution and follow-up</li><li>• Indicate quality status of each verification run</li><li>• Acquire all change data (cards, etc.) generated on the spot.</li><li>• Deliver all verified run materials to the quality assurance data center and apply quality assurance stamps as appropriate</li><li>• Verify actual computer time used to make run associated with given program</li><li>• Verify actual output listing to ensure test cases are properly associated with approved test specification documentation.</li></ul>								

\*Cards, tapes, disc, listing, procedures, specifications

## CHAPTER 8: NONCONFORMING ARTICLES AND MATERIAL CONTROL

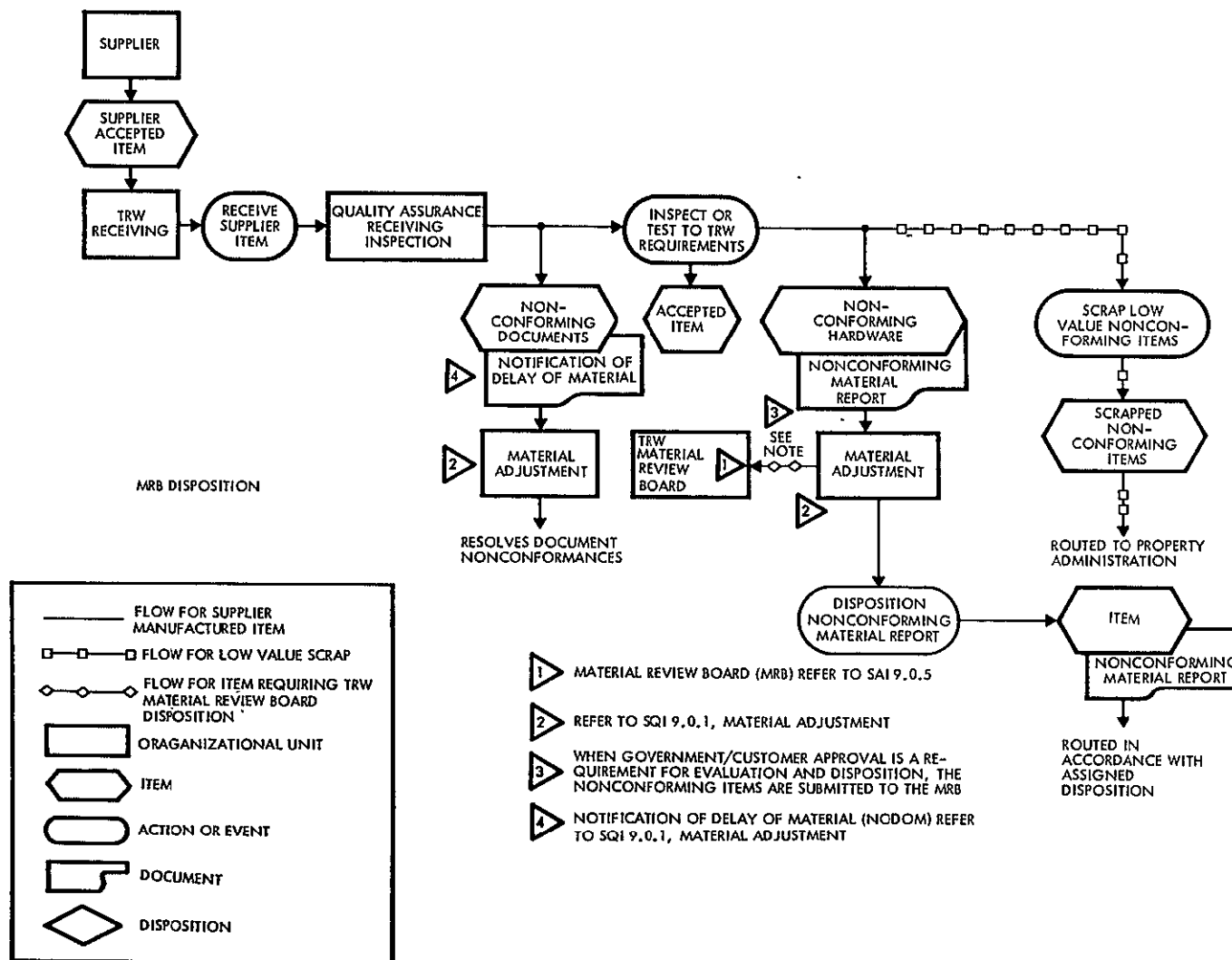
### 1B800 Nonconforming Articles and Material Control

Nonconforming material detected during the receiving, fabrication, assembly, and test inspection operations will be identified, segregated, and withheld from use in controlled areas. To provide positive segregation of discrepant items, controlled areas will be established in the areas of receiving inspection, manufacturing, assembly, and test. When segregation is not feasible or physically possible, the item will be bonded in place and held for material review.

### 1B801 Nonconforming Documentation

Material found discrepant during receiving inspection will be reported on a nonconforming material report (NCMR), forwarded to the incoming material adjustment area for disposition, and reported to the concerned buyer. Based on severity of discrepancy, schedule, input, cost of rework, and other factors at the buyer's disposal, he will either direct return of the material to the supplier or request rework in-house to drawing and specification requirements. For any other dispositions, the buyer will request submission of the material to the evaluation team. The flow chart in Figure 8-1 describes this operation.

TRW Systems Group manufactured items found discrepant at any point during fabrication or assembly operations will be reported on a discrepancy report (DR). Discrepancies which can be reworked to drawing and specification requirements will be dispositioned on the report by an authorized manufacturing representative and concurred by the discrepancy review representative. Discrepancies which cannot be reworked to drawing and specification requirements, will be transferred to a nonconforming material report (NCMR) and submitted to the evaluation team for disposition. The flow chart in Figure 8-2 describes this operation.



**Figure 8-1**  
**SUPPLIER MANUFACTURED ITEMS SYSTEM for controlling nonconforming material**

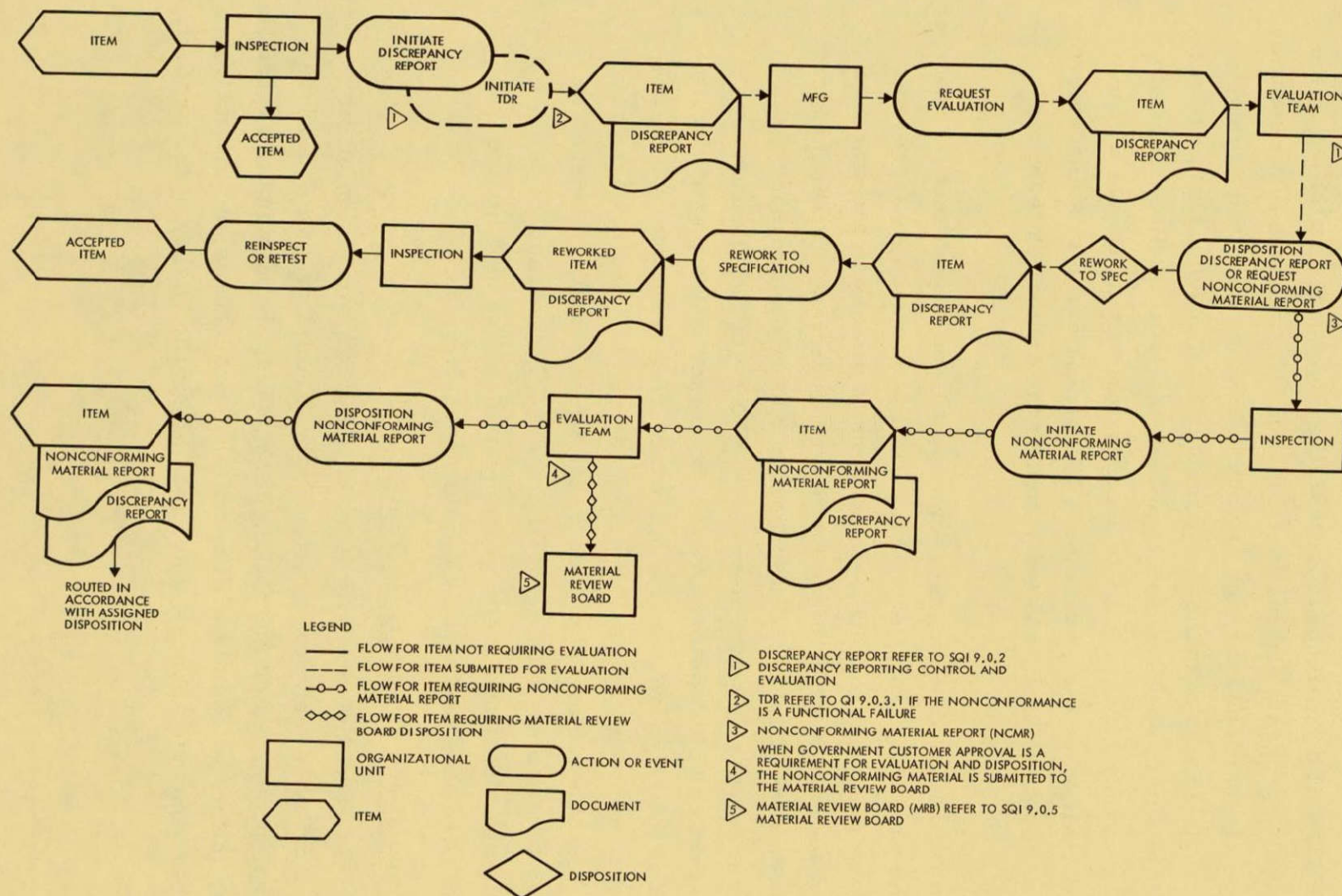


Figure 8-2

TRW MANUFACTURED ITEMS SYSTEM for controlling nonconforming material

Discrepancies discovered during testing will be documented on a test discrepancy report (TDR) and in addition, all test article failures will be reported on the test discrepancy report. Malfunction reporting to NASA/GSFC will be in accordance with the procedures specified in the ERTS reliability program and malfunction reporting plans. Discrepancies which can be dispositioned through rework to specification requirements, repair, or replacement of the test equipment, or through a change to the test procedure within specification requirements, will be dispositioned on the test discrepancy report by the test conductor. Concurrence will also be required. All other discrepancies will be transferred to a nonconforming material report (NCMR) and submitted to the evaluation team for disposition.

When the nature of a discrepancy report item is such that its rework is within the purview of an existing NASA/GSFC or designee approved standard repair procedure (SRP), disposition to rework to the standard rework procedure may be made on the discrepancy report. Discrepancy review personnel will enter the discrepancy report item number and statement rework per Standard Repair - # XXXX" in the "Remarks, Rework Inspection" block of the discrepancy report. Upon satisfactory completion of the standard rework, manufacturing resubmits the discrepancy report item to inspection for acceptance. Standard rework procedures will be reviewed and approved by the project quality manager or his designee prior to use on the ERTS project. Discrepancies noted during compute/operations of the ground data handling system are reported as described in Table 7-7 of this program plan.

#### 1B802 Remedial and Preventive Action

Formal Corrective action will be initiated for correction of design deficiencies or other technical requirements, administrative procedures or practices, processes or processing techniques, inspection or inspection techniques, failure to comply with established procedures and instructions, and any other nonconformances which may affect the quality of the product.

Formal corrective actions will be administered and controlled by a corrective action control center (CACC) and will be available for NASA/GSFC review. All actions initiated will be "closed out" in accordance with steps of the flow chart shown in Figure 8-3. The project quality manager or his designees will monitor the acceptability of corrective actions. Additional corrective actions are identified on the nonconforming material report as appropriate and approved by the material review board.

#### 1B803 Initial Review Disposition

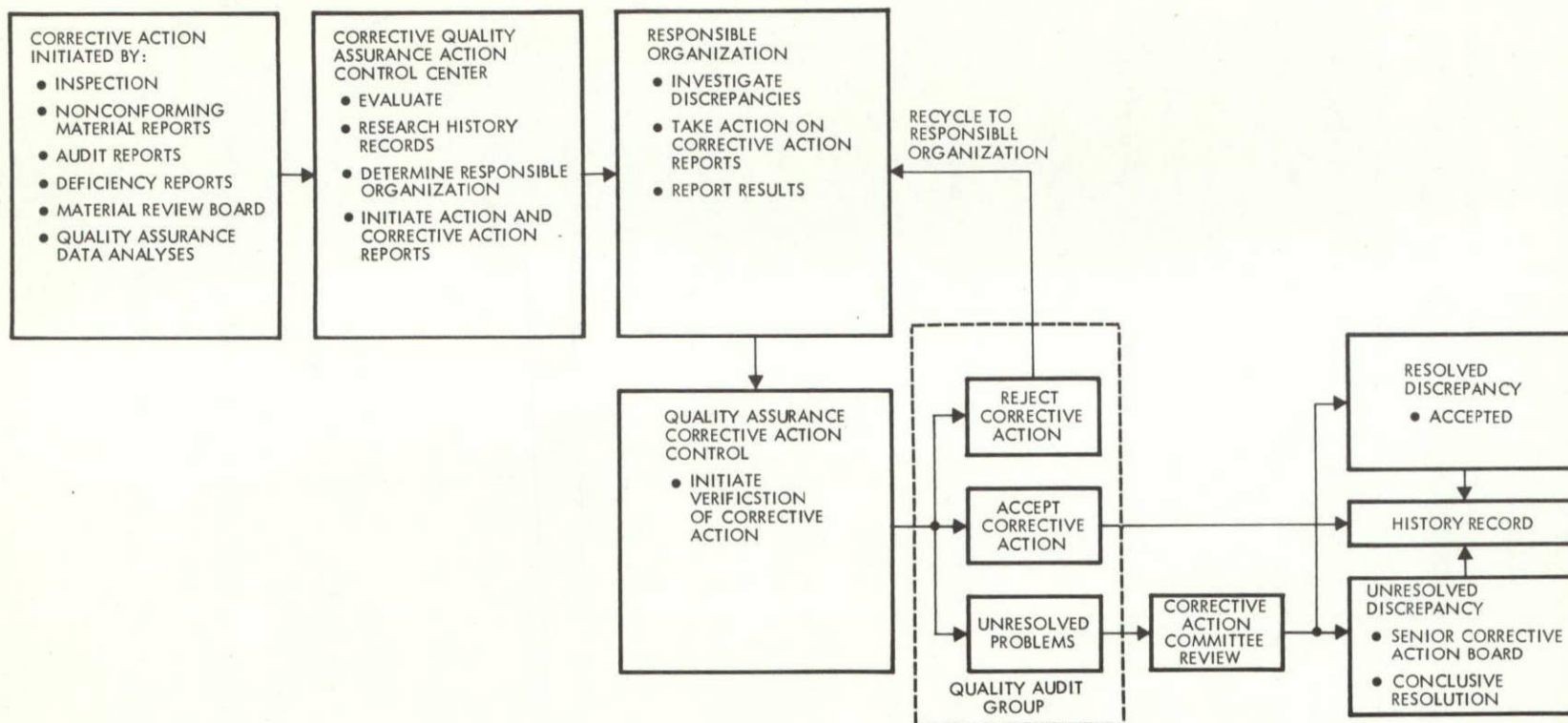
An evaluation team comprises approved quality assurance and engineering personnel and will have the authority to make the following joint dispositions in accordance with discrepant material - reporting, control, and evaluation procedures.

- Return to vendor
- Rework within drawing/specification requirements
- Sort for yield
- Reinspect
- Scrap (when value does not exceed the amount established by the Defense Contractors Administration Services quality assurance representative and the project quality manager on cost plus contracts)

Scrap dispositions, other than those previously described, will require material review board action. In addition, if it is the opinion of the evaluation team that the material be considered for acceptance in the "use-as-is" category or "repaired-to-salvage tolerance", it will be submitted to the material review board for action (see flow charts, Figures 8-1, 8-2, and 8-4).

#### 1B804 Material Review Board

"Repair-to-salvage tolerance", "use-as-is", and certain high value scrap dispositions will require the board's action. It will be composed of three authorized representatives. Each member will be a qualified engineer and familiar with quality, reliability, engineering application, and



DISCREPANCIES ARE IDENTIFIED DURING PRODUCTION, ASSEMBLY AND TEST.  
A CLOSED LOOP SYSTEM IS EMPLOYED TO INSURE TIMELY AND COMPLETED ACTION

Figure 8-3.

### POSITIVE CORRECTIVE ACTION

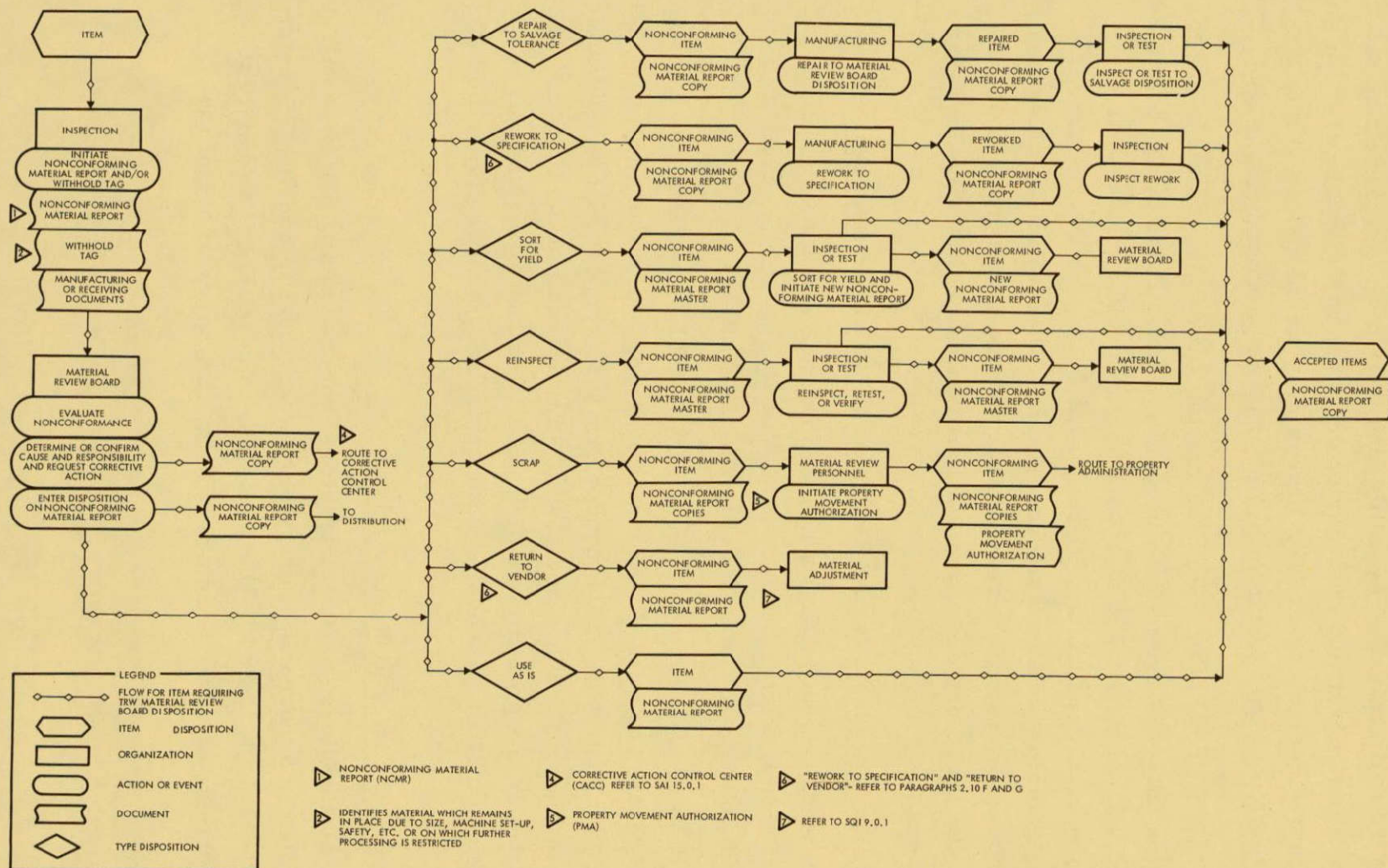


Figure 8-4

FLOW AND DISPOSITION OF NONCONFORMING ITEMS  
through the formal material review board (MRB)

functional requirements of the material under consideration. The material review board will consist of a quality assurance representative who is chairman of the board, and engineering representative appointed from the division having design engineering liaison responsibilities, and a DCAS quality assurance representative having material acceptance authority.

Additional consultant members may be called upon by the board for consultation but will have no vote in the disposition made by the board. The board will be authorized to accept only nonconformances that are judged to be variations which will require a unanimous decision while a dissenting decision will veto the acceptance. Discrepancies classified as deviations or departures from contractual specifications will be submitted to the ERTS project office for coordination with NASA/GSFC for dispositioning.

#### 1B805 Written Requests for NASA Contracting Officer Approval

A deviation is defined as a nonconformance which may have an adverse affect on safety, performance, interchangeability, reliability, weight, durability, or basic objectives of the contract.

Written request for deviations for which TRW recommends a disposition to "repair" or "use-as-is," will be submitted to the NASA contracting officer for approval. Each nonconformance request will be submitted through the material review board with written recommendations and proposed remedial and preventive action. Articles and materials will be withheld from further processing until contracting officer disposition is obtained.

#### 1B806 Supplier Material Review Board

Major suppliers' or subcontractors' nonconforming material will be controlled in accordance with PAR 700-52, 700-53, and 700-55 (refer to Exhibits 1-2, 1-3, and 1-4). Decisions to grant board authority to major suppliers or subcontractors will require concurrence of the customer.

## CHAPTER 9: METROLOGY CONTROLS

### 1B900 General

TRW standard policies and practices exist for assurance and control calibration evaluation, and maintenance of test and measuring equipment in accordance with MIL-C-45662 and NASA requirements. Quality work task description for the metrology effort is described in Table 9-1.

### 1B901 Initial Acceptance

The TRW metrology organization supported by quality assurance and the test equipment custodial organization perform receiving inspection and calibration on new measuring and test equipment. Metrology performs this function to support the normal receiving inspection function within the company.

### 1B902 Evaluation

Test and measuring equipment used for product verification is evaluated for equipment tolerance limits, accuracy, and repeatability, and serves to establish allowable usage factors.

Detailed evaluation will be performed on special measuring and test devices where long established accuracy, stability, and repeatability factors are not available, such as automated test and checkout equipment or special designed equipment for specific measurements as part of the design review. Evaluation of this equipment will establish that tolerance requirements of the product are within the scope and capability of the measuring device. Resultant measurements are those of the product and not of the measuring device and its accuracy and tolerance verification has been established.

### 1B903 Hardware Measurement Processes

When it is discovered that the accuracy of the test equipment will exceed 10 percent of the tolerance of the hardware characteristic to be measured, the test equipment, test item, and test characteristic will be identified. TRW will then submit a recommendation to NASA/GSFC for information and disposition.

Table 9-1. Quality Work Task Description for Metrology

Item Number (Task)	NHB 5300.4(1B)	QASP (Applicable) Number	SQI (Applicable) Number	Task Description	Requirements for Applicable Type of Hardware					
					Eng Models Fab by Manufacturing	Flight Proto and Qual Hardware	Elect Ground Support Equip	Special Purpose Test Equipment	Mech Ground Support Equipment	GDHS
1	902	2.0	2.0.1	Company Standards. Maintain company measurement standards which are traceable and have valid relation to national standards. Company standards are documented, evaluated, and certified by National Bureau of Standards, equipment manufacturer, selected service centers. Standards maintained covers the full spectrum of basic measurement; DC/low frequency - resistance, inductance, capacitance, voltage, current, magnetics; RF/microwave - impedance, attenuation, power, time, frequency, noise, phase; electromechanical - pressure, temperature, force, mass, flow, acceleration, radiation; mechanical/optical - length, flatness, surface finish, angle, roundness, internal/external diameter and levelness.	X	X	X	X	X	X
2	905	2.0	2.0.2	Calibration/Maintenance/Repair of Test Equipment. Perform calibrations traceable to the National Bureau of Standards; maintain, repair measuring, test, and inspection equipment used by TRW Systems Group. Classes of equipment services are to include general purpose electrical, mechanical, optical, electromechanical instruments, special purpose test equipment, and unique items.	X	X	X	X	X	X
3	905	2.0	2.0.3	Control of Equipment. Control measuring, test, and inspection equipment utilizing decals to indicate calibration control status (calibrated, limited use, user validated maintenance, conditional use, inactive, and out-of-calibration control). Issue reports to indicate instrumentation status, such as recall cycle, history, equipment location, custodian, and label designation. Issue computer preprinted calibration work orders for recalling equipment due for calibration/maintenance. Issue computerized delinquency report on user equipment known to be out-of-calibration control. Coordinate with user laboratories to have equipment brought to metrology for action.	X	X	X	X	X	X
4	905	2.0	2.0.2	Evaluation of Equipment. Evaluate equipment under calibration control for reliability by manufacturer model. Analyze each instrument for performance, stability, and service cost. Tabulated data are published in history data summary/manufacturer model summary reports and used for establishing/changing recall cycle, recommendation for preferred purchasing, and selected calibration exemption.	X	X	X	X	X	X

Table 9-1. Quality Work Task Description for Metrology (Continued)

Item Number (Task)	NHB 5300.4(1B)	QASP (Applicable) Number	SQI (Applicable) Number	Task Description	Requirements for Applicable Type of Hardware						
					Eng Models Fab by Manufacturing	Flight Proto and Qual Hardware	Elect Ground Support Equip	Special Purpose Test Equipment	Mech Ground Support Equipment	GDHS	
5	505 901	3.0	3.0.3	Receiving Inspection. Perform receiving inspection on measuring, test, and inspection equipment to assure conformance to procurement documents, specifications, and other applicable requirements when the receiving inspection group does not possess the technical and instrumentation capability.	X	X	X	X	X	X	
6	905 1300	10.0	10.0.1	Inspection Calibration of Government-Furnished Property. Inspect, calibrate, maintain, and evaluate GFP measuring, tests, and inspection equipment under intended use for compliance to the applicable documents and performance requirements.	X	X	X	X	X	X	
7	902 907	2.0	2.0.2	Technical Assistance/Masurement Engineering/Training. Offer technical assistance in resolving measurement problems, design/develop special test standards, conduct training for TRW customer - supplier personnel when necessary on measurement techniques, measurement system evaluation, error analysis to achieve the required quality-accuracy level.	X	X	X	X	X	X	
8	902 905	2.0	2.0.2	Special Measurements. Perform special measurements where precision, accuracy, technique instrumentation are of special nature and beyond the capability of operating groups upon request.	X	X	X	X	X	X	
9	900 902	2.0	2.0.2	Project Support. Provide liaison with project, program office, proposal, and quality program managers to define measurements, calibration requirements, out of calibration, equipment control, and in-house capability. Participate in project design reviews to audit for realistic accuracy, tolerance, instrumentation, and equipment applications.	X	X	X	X	X	X	
10	501	3.0	3.0.1	Vendor Survey. Survey/evaluate new or potential suppliers to assure that measurement capability, calibration/traceability, and equipment control are adequate and offer higher probability that supplier can satisfy the accuracy/reliability requirements.	X	X	X	X	X	X	
11	503 508	4.0	4.0.1	Source Inspection. Conduct source inspection where measurement specialists are required to assure validity of the data, measurement technique, instrumentation, system error, and data reduction.	X	X	X	X	X	X	
12	206 905	2.0	2.0.2	Off-Site Support. Provide off-site and support at launches, remote sites, and vendor/customer facility to service, calibrate, and maintain TRW/customer equipment as required in the quality assurance launch activities plan.		X	X		X	X	

Table 9-1. Quality Work Task Description for Metrology (Continued)

Item Number (Task)	NHB 5300.4(1B)	QASP (Applicable) Number	SQI (Applicable) Number	Task Description	Requirements for Applicable Type of Hardware					
					Eng Models Fab by Manufacturing	Flight Proto and Qual Hardware	Elect Ground Support Equip	Special Purpose Test Equipment	Mech Ground Support Equipment	GDHS
13	903 904 905	2.0	2.0.2	Error Analysis. Perform error analysis on parts, units, systems for bias error, random error, system error and evaluate and derive the overall realizable measurement level upon request from engineering.	X	X	X	X	X	X
14	300	2.0	2.0.2	Review Specifications, Procedures, and Documents. Review specifications, proposals, procurement documents, test procedures for realistic tolerancing practice, accuracy call-out, proper requirements as requested by the project quality manager.	X	X	X	X	X	X
15	900	2.0	2.0.2	Prepare /Review/Maintain Written Procedures. Prepare and maintain written procedures instructions, and diagrams defining calibration requirements for general purpose test equipment, special purpose test equipment, and electronic ground operating "standards" units.	X	X	X	X	X	X

#### 1B904 Calibration Measurement Processes

When the accuracy of metrology standards exceed 25 percent of the tolerance of the characteristic on the test or measuring equipment being calibrated, the equipment and characteristic will be identified and TRW's recommendation submitted to NASA/GSFC for information.

#### 1B905 Calibration Controls

TRW metrology maintains measurement standards traceable to the National Bureau of Standards. Secondary standards are certified to the primary standards and may be removed in in-plant areas, as required for calibration of equipment.

The effects on the calibration of standards and equipment during handling, storage, and transportation is the primary responsibility of the TRW Metrology Department.

Identification and labelling of measuring and test equipment are in accordance with standard metrology practices and procedures. Calibration status and identification are accomplished by application of an appropriate instrument calibration label. TRW instrument calibration labels are described in quality assurance metrology procedures. Instrument calibration labels in use are calibrated, limited calibration, user validated, conditional use, inactive, maintenance, and indicator only relative to the end use of the equipment.

When size, configuration, or functional characteristic of the equipment prohibits the application of calibration labels, an identifying small color dot is applied to the item to reflect the next calibration due date. Master calibration color code charts are displayed and available throughout the manufacturing and test areas showing the required color code per calendar month. Calibration due dates fall on the last working day of the month where such color codes are used. Calibration intervals are established by metrology, based on equipment stability, application, and usage.

The TRW recall system is the responsibility of metrology and is an automated system of preprinted test equipment calibration work orders which are sent to the test equipment custodial organization. If the custodial organization fails to respond to the recall system, a formal "Corrective Action Request" is submitted. When the equipment is not submitted for recalibration, test inspectors prohibit use of such equipment from the performance of hardware acceptance testing.

Calibration records are maintained in the "Test Equipment by Control Number List" which provides manufacturer/model/description, calibration interval, control status, dates of last and next due calibration, accountable department and location, and also applicable calibration procedure or specification. The metrology technician performing the calibration affixes his stamp impression on the tag placed on the equipment.

The metrology organization with support by quality assurance has the responsibility to analyze equipment maintenance data to detect quality problems.

#### 1B906 Environmental Requirements

Metrology maintains environmentally controlled work areas as required for calibration of equipment.

#### 1B907 Remedial and Preventive Action

Quality assurance will initiate test discrepancy reports (TDR) when the accuracy of equipment on product acceptance tests is questioned or when the calibration period has expired.

Out-of-calibration control stickers are affixed to the subject test equipment.

## CHAPTER 10: STAMP CONTROLS

### 1B1000 Stamp Control System

A system for the control of inspection stamps is a standard quality practice outlined in Section 8 of the quality assurance manual. Auditing is performed by the quality assurance staff to assure compliance. Inspection stamps are applied directly to the item or the accompanying paperwork so that the specific inspection status of an item is readily determined for all operations from receiving inspection through final inspection and/or acceptance test.

A record of assignment of each inspection stamp is maintained by quality assurance and is available to the cognizant Government/customer representative. Traceability of each inspection and test stamp to its user is maintained and verified.

Worn or damaged stamps that produce illegible or otherwise unsatisfactory stamp impressions are returned for replacement. Returned or lost stamps are immediately reported to quality assurance for revision of assignment records. Serial numbers of stamps lost or stolen are not reissued for a period of six months. Where physical limitations or configuration of articles does not allow the application of an inspection impression stamp, a properly completed inspection acceptance tag is attached to each individual item. Where the size is not practical, an inspection acceptance tag is attached to the item's container. Finished products that do not reflect inspection acceptance are not accepted for use. Quality assurance control and verification of inspection status of software is described in Table 7-7.

### 1B1001 Stamp Restriction

TRW fabrication and inspection stamps do not bear any NASA or Defense Contractors Administration Services designations.

## CHAPTER 11: HANDLING, STORAGE, PRESERVATION, MARKING, LABELING, PACKAGING, PACKING, AND SHIPPING

### 1B1100 Handling and Storage

Through all phases of the manufacturing assembly and testing processes, quality assurance personnel monitor and document the handling of articles and deliverable end items. Items will be inspected at predetermined points to ensure that they are adequately protected and that the characteristics of quality are not impaired or degraded through handling. The operations for handling of the observatory at the launch site will be in accordance with established procedures modified for ERTS.

Storerooms for component parts awaiting assembly, subassemblies awaiting further assembly, or finished assemblies awaiting spacecraft/observatory integration or shipment, will be controlled limited access areas. Items for project use will be segregated. Parts and assemblies will be identified and binned by part number, serial number, and/or lot control number, and will show evidence of acceptance. Raw materials will be coded and identified. Limited shelf-life items will show shelf-life expiration data. Periodic audits of storeroom facilities will be conducted by quality assurance personnel to verify adequate maintenance of items.

The completed observatory and spare flight equipment will be stored in environmentally controlled storage areas, enclosed in protective containers, appropriately designed to preclude degradation of or inadvertent damage to the equipment in the storage and handling environments to which the hardware will be exposed. If prolonged storage is required between observatory completion and launch, periodic (shelf-life) functional testing will reassess flight readiness.

### 1B1101 Preservation, Marking and Labeling, Packaging, and Packing

Quality assurance personnel will verify and monitor preservation controls to assure that articles subject to atmospheric deterioration are properly cleaned and packaged. It will also monitor labeling to engineering drawing and specification requirements. TRW Process Specification PR12-1 supplements the drawing specifying how hardware physically is

marked. Specific procedures for the handling, storage, and labeling of software will be in accordance with procedures established for the Data Center by Software Information Systems Division, Product Assurance and described in the Configuration Management Plan.

Quality assurance monitors packaging for adequacy of protective containers and packing materials for prevention of damage in shipment or storage, compliance or marking requirements, inspection of package before and after shipping or storage in-plant, accessibility of deliverable item if inspection is required in the container, and adequacy and operation of recording devices for measurement of special environments.

#### 1B1102 Shipping

Quality assurance personnel monitor shipping operations to ensure that deliverable end items reflect that all fabrication test and inspections have been satisfactorily completed, documented, and accepted; accepted articles are segregated from articles awaiting test results or final disposition; deliverable end items are complete; articles have been preserved and packaged in accordance with the project requirements; articles and containers have been identified and tested as required in accordance with proper procedures and specifications, and that required data are properly located and included as specified in the shipping procedure or plan.

## CHAPTER 12: SAMPLING PLANS, STATISTICAL PLANNING, AND ANALYSIS

### 1B1200 Sampling Plans

Sampling will be conducted in accordance with company sampling procedures, MIL-STD-105, or MIL-STD-414. Sampling inspection will only be applied when the articles being sampled are not considered critical. Sampling plans may be used by TRW subcontractors or suppliers with prior approval from TRW quality assurance.

Sample testing will be employed wherever necessary, e.g., chemical analysis and hardness tests, to establish a measurable confidence of the quality of materials or special processes.

### 1B1201 Statistical Planning and Analysis

Statistical planning and analysis may be implemented whenever such operations can economically obtain data. Records and analysis of data indicative of quality levels will be maintained and distributed when it is necessary to isolate deficient conditions and to provide the basis for corrective action and conformance control.

## CHAPTER 13: GOVERNMENT PROPERTY CONTROL

### 1B1300 Contractor's Responsibility

Government property is inspected on receipt for proper identification, as-received condition, completeness, correct size, type, operational characteristics, and supporting documentation. This includes both space-borne and ground equipment. Provisions for periodic reinspection of government-furnished property after the custodian has been established, is implemented to assure that equipment is not damaged or deteriorated by handling, use, or storage, and that records reflect proper maintenance, use, and application. Equipment is identified by TRW customer identification tags and associated serial numbers.

Excess government-furnished property, which is no longer needed in the performance of the specific government contract to which the property is being charged, is segregated and controlled in a bonded area until inspection and final disposition by the cognizant government agency are completed. Property custodians perform periodic inspections of excess government-furnished property to determine conditions of both electrical and mechanical equipment and maintains records for detailed backup of condition coding.

### 1B1301 Unsuitable Government Property

Equipment found by quality assurance inspection to be damaged, malfunctioning, or not suitable for use, is reported to the cognizant government representative by the Property Department and is controlled in accordance with company standard practices.

Existing government special test equipment (TRW built) from a previous OGO contract which may be modified and used on this project, may be repaired, reworked, or modified as required. Such rework operations will be controlled in accordance with project requirements for the equipment-type being modified.

APPENDIX A  
EXHIBITS  
Exhibit 1-1  
**PROJECT QUALITY SYSTEM REQUIREMENTS**  
PROJECT ATTACHMENT TO SQI 1.1.1

PROJECT ERTS, Earth Resources Technology  
DATE 29 December 1969 REV. New Satellite

Project Quality System Requirements contained herein are in accordance with requirements of the applicable Project Quality Plan or Inspection Plan.

SQI NUMBER	APPLICABLE AS WRITTEN	APPLICABLE WITH QUALITY PLAN VARIATIONS (DETAILED ON CONT. SHEETS)	NOT APPLICABLE ON THIS PROJECT
1.1.1.	X		
1.1.2	NOT RELEASED		
1.2.1	X		
1.2.2	X		
2.0.1	X		
2.0.2	X		
2.0.3	X		
3.0.1	X		
3.0.2	X		
3.0.3	X		
3.0.4	X		
4.0.1	X		
4.0.2	X		
4.0.3	X		
4.0.4	X		
4.0.5	X		
4.0.6	X		
4.0.7	X		
4.0.8	X		
4.0.9	X		
4.0.10	X		
4.0.11	X		

SQI NUMBER	APPLICABLE AS WRITTEN	APPLICABLE WITH QUALITY PLAN VARIATIONS (DETAILED ON CONT. SHEETS)	NOT APPLICABLE ON THIS PROJECT
5.0.1	X		
5.0.2	X		
7.0.1	X		
8.0.1	X		
9.0.0	X		
9.0.1	X		
9.0.2	X		
9.0.3	X		
9.0.5	X		
10.0.1	X		
11.0.1	NOT RELEASED		
11.0.2	NOT RELEASED		
12.0.1	X		
14.0.1	X		
14.1.1	X		
15.0.1	X		
15.0.2	X		
16.0.1	X		
18.0.1	X		

PROJECT QUALITY MANAGER

DIVISION PRODUCT ASSURANCE MANAGER

PROJECT MANAGER

DIRECTOR OF QUALITY ASSURANCE

PAR 700-52  
November 11, 1969

PROCUREMENT

PRODUCT ASSURANCE REQUIREMENTS

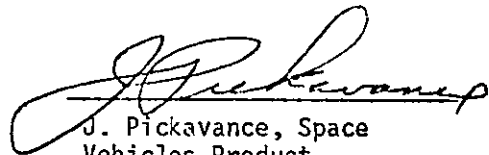
INSPECTION SYSTEM PROVISIONS

PROJECT ERTS SUPPLIERS

Approved:



J. K. Holau  
Project Quality Manager



J. Pickavance, Space  
Vehicles Product  
Assurance Manager

TRW  
SYSTEMS GROUP

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PAR 700-52  
November 11, 1969

CHANGE RECORD

Revision	Date	Description	Pages Affected

PAR 700-52  
November 11, 1969

PRODUCT ASSURANCE REQUIREMENTS  
PROJECT ERTS

1.0 PURPOSE:

- 1.1 To define the detail TRW Systems Group Quality Assurance requirements to suppliers of material for the ERTS Program.
- 1.2 To provide suppliers with the guidelines necessary to meet the basic inspection system requirements of the purchase order.

2.0 GENERAL REQUIREMENTS:

- 2.1 The supplier shall provide and maintain an inspection system meeting all the requirements of NASA Quality Publication NPC 200-3, "Inspection System Provisions for Suppliers of Space Material, Parts, Components and Services," dated April 1962, and the supplemental requirements of this document.
- 2.2 In addition to the requirements of this document PAR 700-52 the supplier shall meet the requirements of the supplemental clauses TRW Systems Form 1991, "Supplier Quality Attachment I to SQI 3.0.3." when the supplemental clauses are specified on the purchase order/subcontracts.
- 2.3 For the purpose of this document, any references to contractor in NPC 200-3 shall mean the individual firm or corporation to whom the purchase order or subcontract is addressed, and shall be referred to herein as the supplier.
- 2.4 The supplier is responsible for implementing all the terms of this document whether the work is performed by the supplier or his subcontractors.
- 2.5 Changes to the requirements stated in this document will not be recognized unless written approval has been granted to the supplier by TRW Systems Group. Requests for changes or waivers must be submitted to TRW Systems Group in writing and must include as a minimum:
  - Clear description of change or waiver
  - Reason
  - Effect on cost, schedules, and basic quality requirements
  - Alternate method proposed for controlling the quality of the hardware

- 2.5.1 All correspondence in connection with the document must be submitted through the cognizant TRW Systems Group Materiel representative. Authorized TRW Systems Group changes to this document will be by Purchase Order Change Notice.

### 3.0 AMENDMENTS TO NPC 200-3

#### 3.1 Preparation and Submission of Suppliers' Inspection Plan (NPC 200-3, Section 2.2)

The supplier shall submit three (3) copies of a written inspection plan to TRW Systems Group for approval within thirty (30) days after purchase order award. The format of the supplier's plan shall be in substantial accordance with each section heading of NPC 200-3 and the additional requirements of this document.

- ° The supplier's inspection plan must include appropriate charts which present a clear definition of the proposed Quality Inspection Systems; e.g., product and material flow chart, inspection points, etc.
- ° Where applicable, the supplier must reference under each section of the inspection plan, his standard quality procedure by title and number for accomplishing that specific requirement. These procedures must be made available for TRW Systems Group Quality Assurance as part of the inspection plan.

NOTE: The supplier's inspection plan must respond to each section heading of NPC 200-3. If in the opinion of the supplier a specific section of NPC 200-3 is not applicable, he must so state in the plan and give reasons.

#### 3.2 Government Source Inspection (NPC 200-3, Section 3.2)

When the purchase order specifies Government Source Inspection required, all work is subject to inspection and test monitoring by the Government representative. Notification should be in advance of the inspection and/or test operation at a time mutually agreed.

Delegation of Material Review Board authority to the Government representative that normally services the suppliers plant though not normally granted (Para. 3.4), shall be at the discretion of the responsible Government agency in resident at TRW Systems Group.

### 3.3 Process Control (NPC 200-3, Section 3.7)

TRW Systems Group reserves the right to inspect and approve the supplier's control of special processes during the life of the purchase order. The supplier shall submit as an addendum to his inspection plan, a listing of special processes performed or subcontracted for this purchase order. This list shall identify the process type and specification document control number. The supplier's detailed process control procedures must be available for on-site audit by TRW Systems Group Quality Assurance or submitted to TRW Systems Group upon request.

The supplier will be fully responsible for controlling his process supplier. Records indicating these controls must be available for TRW Systems Group Quality Assurance review (on-site). In addition, the supplier shall submit as part of his inspection plan, a general procedure for controlling his special process suppliers (audits, surveys, certifications, etc.)

All soldering performed on this procurement must be consistent with the requirements of NHB 5300.4(3A) "Requirements for Soldered Electrical Connections," May 1968 edition.

### 3.4 Non-Conforming Material (NPC 200-3, Section 3.8)

The entire Section 3.8 of NPC 200-3 shall be amended to read:

- ° TRW Systems Group will normally not grant Material Review authority to its suppliers.
- ° If, during inspection, any materials or products are rejected for nonconformance to drawing or specifications, they must be positively identified and isolated from conforming materials or products. However, the supplier may make dispositions as follows:
  - a) Scrap: If materials and/or products are determined unfit for use, they may be scrapped at no additional cost to the purchase order. They must be positively identified prior to disposal to prevent their inadvertent use.
  - b) Complete or Rework to Specification: If it is determined that the materials and/or products can be completed or reworked to drawing and/or specification requirements, this may be accomplished at no additional cost to the purchase order.
- ° If the materials or products cannot be completed or reworked to specification requirements, and it is not feasible to scrap, then the supplier may contact the cognizant TRW Systems Group buyer for authorization

to submit a "Supplier Information Request" (SIR, Form 2212) for TRW Systems Group Material Review and evaluation. The SIR will be returned to the supplier by the TRW Systems Group buyer, and will outline the course of action to be followed.

- ° The following decision prerogatives are not given to the supplier.
  - a) "Use As Is" if a variation or deviation exists on the materials or products.
  - b) "Rework beyond drawing or specification requirements" (repair) by means of unapproved techniques, processes, etc., (e.g., chrome plating undersize shafts up to drawing dimensions).

NOTE: For the purpose of this document, Variations and Deviations are defined as follows:

- a) Variation: Any nonconformance to drawing or specification requirements which, in the opinion of TRW Systems Group Quality Assurance, does not adversely affect safety, weight, interchangeability, service life, reliability, or performance.
- b) Deviation: Any nonconformance to drawing or specification requirements which, in the opinion of TRW Systems Group Quality Assurance affects safety, weight, interchangeability, service life, reliability or performance. Nonconformance to specification on fuels, lubricants and chemicals are considered deviations.

### 3.5 Control of Inspection, Measuring and Test Equipment (NPC 200-3, Section 3.9)

The supplier's inspection system shall ensure that all inspection and test equipment utilized in acceptance inspection or testing of ERTS material is calibrated and is within the effectivity limits established by a procedure as defined below.

This procedure shall consider the intended accuracy and the wear or drift characteristics of the tool involved. It shall provide for use of appropriate calibration standards which are traceable to the National Bureau of Standards and establish a calibration frequency such as to avoid the effects of wear or drift.

In the event that the supplier's facilities do not include such capabilities, use of an approved outside calibration laboratory is authorized by TRW Systems Group Quality Assurance.

The supplier must, however, control all Metrology activity through a written procedure defining the minimum requirements of method, frequency, recall, and visible evidence of conformance. This procedure shall be included with the submission of the supplier's Inspection Plan discussed in Section 3.1 of this document.

### 3.6 Records of Inspection and Test (NPC 200-3, Section 3.13)

The supplier shall submit with each end-item shipment a certified copy of his inspection and/or variables data as required by the purchase order indicating continuation data acceptance of the unit nonconformance data and operating time/cycle record. In addition to the above technical data, the supplier shall submit with each shipment a "Certificate of Conformance" which reads substantially as follows:

"The materials, parts, and processes furnished in this shipment were produced in conformance with all contractually applicable specifications referenced in or furnished with the purchase order. The materials and items furnished have been subjected to and passed all examinations and tests required by the purchase order with objective evidence such as inspection and test data on file and available for TRW Systems Group examination."

This certificate must reference the purchase order number, any purchase order change numbers, serial numbers if any, production lot number, purchase order number, quantity of items and date of shipment. The certificate must be signed by a senior member of the supplier's management in the facility producing the supplies, who fully understands the facts to which he is attesting; title of person must also be stated. Records of all inspections and tests shall be made available to TRW Systems Group when requested.

## 4.0 ADDITIONAL REQUIREMENTS

### 4.1 Materials and Parts Traceability

A. Material and parts traceability shall be required on:

- ° Electrical Components. Identification of electrical and electronic parts for qualification and flight articles such as semiconductors, relays, transformers, connectors, etc., shall be traceable "to the manufacturer, date of manufacture, and the manufacture's lot control number."

- ° Raw Material. Traceability is required to the physical and chemical analysis. Non-metal raw material requires a "Certificate of Conformance" to the applicable specifications; e.g., glass, plastic, etc.
- ° Special Materials or Products. Traceability is required to the physical and chemical analysis of such special materials as titanium, columbium, or niobium. When such materials are used in the fabrication of flight articles of any description, traceability is required similar to that of electrical and electronic manufacture described above.
- ° The supplier's material control system must provide a positive method for tracing the above material from the highest TRW Systems Group procured level of each assembly down to the individual raw material or component lots. Records must be available at the supplier's facility for TRW Systems Group review upon request.

B. Exemptions from Material and Parts Traceability

- ° Material and products which are utilized in non-critical applications and are not otherwise required to be identified for traceability as described above, may be considered exempt from this requirement.
- ° A list of such items is shown below for reference. If in the opinion of a supplier, other items he supplies also fall within this category, he may request approval by supplying an additional list with his reasons through the cognizant TRW Systems Group Materiel Division representative.

Items (General Sample List) Exempt from Traceability

AN Fittings	*Nuts
AND Fittings	Packing Material
*Bolts	Pins
Buss Wire	Rivets
Clamps	*Screws
Clips	Shackles
Eyelets	Shims
Identification Plates	Solder
Insulation Tubing	Solder Fluxes
Lacing Cord	Spacers
MS Fittings	Studs
Mylar (as used for	Tape
Welded Module	Washers
"End Cards"	

\*NOTE: All titanium alloy bolts, nuts and screws will be traceable to manufacture, date of manufacture and manufacturer lot code.

4.2 TRW Systems Group Source Surveillance

Periodic audits may be made by TRW Systems Group Quality Assurance in coordination with Materiel during the life of the purchase order to determine compliance with this document and the extent to which the specified procedures are being followed by the suppliers. Upon completion of the audit, the supplier will be notified in writing of those areas requiring correction. The supplier will be given an appropriate period of time within contractual limits to correct deficiencies. If corrective action is not taken within this period, the contract will be considered to be in default by TRW Systems Group and will be subject to immediate termination.

TRW Systems Group Quality Assurance reserves the right to interpret the extent to which this document applies on supplies and services for each purchase order.

TRW Systems Group may assign resident or itinerant Quality Assurance personnel to the supplier's facility during performance of the purchase order. The supplier must, during the supplier's regular business hours, or at such other time as may be necessary, permit such Quality Assurance personnel access to his facilities for determination of compliance with this document and must furnish without cost to TRW Systems Group such facilities and services which may reasonably be required in support thereof.

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Exhibit 1-3

PAR 700-53  
November 11, 1969

**PROCUREMENT  
PRODUCT ASSURANCE REQUIREMENTS  
QUALITY SYSTEM PROVISIONS**

**PROJECT ERTS**

**SUBCONTRACTS**

**TRW**  
SYSTEMS GROUP

Approved:

  
PROJECT QUALITY MANAGER

  
J. Pickavance, Manager  
Space Vehicles Product Assurance

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PAR 700-53  
November 11, 1969

CHANGE RECORD

Revision	Date	Description	Pages Affected
DR1	11-11-69		

PRODUCT ASSURANCE REQUIREMENTS  
PROJECT ERTS

1.0 PURPOSE:

- 1.1 To define the detail TRW Systems Group Quality Assurance System requirements for major or complex assemblies or subsystems for the ERTS Program.
- 1.2 To provide a uniform method of specifying on procurement documents the subcontractor's obligations to assure that supplies or services conform to quality and other procurement document requirements.

2.0 GENERAL REQUIREMENTS:

- 2.1 The subcontractor shall provide and maintain a quality control system meeting all of the requirements of NASA quality publication NHB 5300.4(1B) "Quality Program Provisions for Aeronautical and Space Systems Contractors," dated April 1969, and the supplemental requirements of this document.
- 2.2 In addition to the requirements of this document, PAR 700-53, the subcontractor shall meet the requirements of the supplemental clauses TRW Systems Form 1991, "Supplier Quality Attachment I to SQI 3.0.3" when the supplemental clauses are specified on the purchase order/subcontracts.
- 2.3 For the purpose of this document, any references to contractor in NHB 5300.4(1B) shall mean the individual firm or corporation to whom the purchase order or subcontract is addressed, and shall be referred to herein as subcontractor.
- 2.4 The subcontractor is responsible for implementing all the terms of this document whether the work is performed by the subcontractor or his suppliers.
- 2.5 Changes to the requirements stated in this document will not be recognized unless written approval has been granted to the subcontractor by TRW Systems Group. Requests for changes or waivers must be submitted to TRW Systems Group in writing and must include as a minimum:
  - ° Clear description of change or waiver
  - ° Reason
  - ° Effect on cost, schedules, and basic quality requirements
  - ° Alternate method proposed for controlling the quality of the hardware

2.5.1 All correspondence in connection with this document must be submitted through the cognizant TRW Systems Group Materiel representative. Authorized TRW Systems Group changes to this document will be by purchase order change notice.

3.0 AMENDMENTS TO NHB 5300.4(1B):

3.1 Quality Program Management and Planning (Section 1B200)

Management responsibility for control of the quality program must be clearly defined in the subcontractor's organization. The subcontractor shall assign a manager responsible for directing all quality program activities with the authority to implement all of the requirements of this subcontract.

Quality program status shall be reported periodically and shall include information concerning the implementation of quality program requirements, significant quality problems and attendant corrective action involving procurement fabrication and test operations, quality defect trends and quality program audits.

The subcontractor shall submit to TRW Systems Group for approval, three (3) copies of a detailed Quality Program Plan not later than thirty (30) days after contract award. The format of the subcontractor's quality program plan shall be in accordance with the section headings of NHB 5300.4(1B).

- ° Include appropriate charts which may present a clear description of the proposed quality system; e.g., organization chart, general manufacturing flow charts, material flow, etc.
- ° Where applicable, the subcontractor shall reference under each section of his quality plan, his standard quality procedure number and title for accomplishing that specific requirement. These standard procedures must be made available for TRW Systems Quality Assurance review upon request.

3.2 Design and Development Controls (Section 1B300)

The subcontractor must maintain a system for the control of experimental, engineering, manufacturing, tooling, and test drawings and specifications. Such systems must guarantee that only drawings, specifications, and changes thereto, of the correct change level, are available to operational

personnel at the appropriate points of manufacture, inspection, and test. The system must guarantee the removal of documents of incorrect change level from the manufacturing, inspection and test areas.

The subcontractor/supplier must maintain a system for implementing, recording and verifying changes in product configuration at specified change effectivity points. When design is the subcontractor's responsibility, but design changes require TRW approval prior to incorporation and/or production, Class I changes shall not be made in design or manufacture without the written approval of TRW. When the subcontractor contemplates changes to a design that is his responsibility, such changes must be evaluated for their adequacy in relation to standard engineering and design practices, and with respect to the purpose of the product to which the drawing or specification relates.

Quality Assurance participation in design reviews and design changes shall be made to ensure inspectability, facilitate production and incorporate attendant quality considerations.

### 3.3 Procurement Controls (Section 1B500)

TRW Systems Group may assign resident or itinerant Quality Assurance personnel to the subcontractor's facility during performance of the subcontract. The subcontractor must, during regular business hours, or at such other times as may be necessary, permit such Quality Assurance personnel access to his facilities for determination of compliance with this document and must furnish without cost to TRW Systems Group such facilities and services which may be reasonably required in support thereof.

Periodic audits may be made by TRW Systems Group Quality Assurance in coordination with Materiel during the life of the subcontract to determine compliance with this document and the extent to which the specified procedures are being followed by the subcontractor. Upon completion of the audit, the subcontractor will be notified in writing of those areas requiring correction. The subcontractor will be given an appropriate period of time within contractual limits to correct deficiencies. If corrective action is not taken within this period, the contract will be considered to be a default by TRW Systems Group and will be subject to immediate termination.

When the subcontract specifies Government Source Inspection required, all work is subject to inspection and test monitoring by the Government representative. Notification should be in advance of the inspection and/or test at a time mutually agreed.

Delegation of Material Review Board authority to the Government representative that normally services the subcontractor's plant shall be at the discretion of the responsible Government agency at TRW Systems Group.

### 3.4 Fabrication Controls (Section 1B603)

TRW Systems Group reserves the right to inspect and approve the subcontractor's control of special processes during the life of the purchase order. The subcontractor shall submit as an addendum to his inspection plan, a listing of special processes performed or subcontracted for this purchase order. This list shall identify the process type and specification document control number. The subcontractor's detailed process control procedures must be available for on-site audit by TRW Systems Group Quality Assurance or submitted to TRW Systems Group upon request.

The subcontractor will be fully responsible for controlling his process supplier. Records indicating these controls must be available for TRW Systems Group Quality Assurance review (on-site). In addition, the subcontractor shall submit as part of his Quality Program Plan, a general procedure for controlling his special process suppliers (audits, surveys, certifications, etc.)

All soldering performed on this subcontract must be consistent with the requirements of NHB 5300.4(3A) "Requirements for Soldered Electrical Connections," May 1968 edition.

### 3.5 Inspections and Tests (Section 1B700)

An end-item inspection and test report shall be prepared and transmitted with the subcontract end-item and shall include the following:

- ° End-item configuration list
- ° End-item nonconformance record
- ° Copy of end-item systems acceptance test reports or procedures which include weight, variables test data and results
- ° List of critical and time/temperature sensitive articles
- ° Operating time/cycle record of system and subsystem, where applicable
- ° Final assembly build-up and test procedure, including end-item test article replacements.

Records of all inspections and tests shall be made available to TRW Systems Group for review when requested.

### 3.6 Nonconforming Article and Material Control (Section 1B800)

TRW Systems Group will normally not delegate material review authority to its subcontractors, who may perform preliminary reviews and make dispositions in accordance with the provisions of 1B803. If a major subcontractor to TRW has design cognizance, he may request authority to establish a formal Material Review Board for purposes of making dispositions on materials or products on which variations exist. Deviations can only be dispositioned by NASA by means of a request for contractual waiver. The granting of variation materials review authority by TRW is contingent upon concurrence by TRW's customer and the cognizant Government Inspection Agency.

For purposes of this document, Variations and Deviations are defined as follows:

- ° "Variations": Any nonconformance to drawing or specification requirements which, in the opinion of TRW Systems Group Quality Assurance, does not adversely affect safety, weight, interchangeability, service life, reliability or performance.
- ° "Deviation": Any nonconformance to drawing or specification requirements which, in the opinion of TRW Systems Group Quality Assurance does adversely affect safety, weight, interchangeability, service life, reliability, performance, or the basic objectives of the contract.

If a major subcontractor wishes to request Variation Material Review authority from TRW Systems Group, he must submit the following to TRW Systems Group Quality Assurance via TRW Systems Group Materiel. Complete documentation of the proposed Material Review Board organization and the policy under which the board proposes to operate. This documentation must include:

- ° Organization chart(s) showing the line authority of all proposed Engineering and Quality personnel involved.
- ° Complete resumes of proposed personnel, showing their backgrounds, experience, education, etc.
- ° Copies of proposed detailed operating procedures.
- ° Copies of all proposed forms, tags, etc., and a description of their usage.
- ° Complete description of the cause investigation and corrective action system the supplier

proposes to use to prevent the recurrence of all variations that the proposed board will review disposition.

When a supplier is approved to conduct formal material review on Variation, TRW Systems Group reserves the right to reject the decision of the supplier's Materials Review Board; additionally, TRW reserves the right to reject materials or products covered by such decisions after delivery at a TRW Systems Group facility.

The subcontractor's cognizant Government Quality Assurance representative must approve all decisions made by the other two members of the subcontractor's Material Review Board.

The subcontractor's Material Review Board can make the following decisions:

- ° Scrap: Any one (1) member of the board may make a scrap decision without the concurrence of the other two (2) members.
- ° Reject (Return to Vendor): Any one (1) member of the board may make a reject decision without the concurrence of the other members.
- ° Rework to Specification: If the nature of proposed rework is minor, and does not require engineering action, the decision to rework may be made by the quality member of the board. Major rework requires engineering members concurrence.
- ° Rework Beyond Specification: This decision requires concurrence of all members of the board. At the time this decision is made, it must be decided whether the extent beyond specification constitutes a variation or a deviation; this decision requires the concurrence of all members of the board, as a deviation cannot be accepted.
- ° Use As Is: This decision requires concurrence of all members of the board. NOTE: Deviations cannot be accepted by Material Review Board.

### 3.7 Metrology Controls (Section 18900)

The calibration of measuring and test equipment must be in conformity with MIL-C-45662A.

### 3.8 Handling, Storage, Preservation, Marking, Labelling, Packaging, Packing, and Shipping (Section 181100)

The subcontractor must provide work instructions to

personnel involved in handling, storage, preservation, marking, packaging, and shipping to protect the quality of materials, and products. These instructions must prevent damage, loss, deterioration, or substitution of materials and products. Instructions of this type specify the use of special crates, boxes, containers, transportation vehicles and any other facilities to prevent damage and facilitate materials handling and storage.

Materials and products subject to deterioration and/or corrosion during fabrication or interim storage must be cleaned and preserved by methods which will prevent such deterioration and/or corrosion.

The subcontractor's system for the control of quality must provide a regularly scheduled audit of the handling and storage functions. Any nonconformances must be corrected and action taken to prevent recurrence.

#### 4.0 ADDITIONAL REQUIREMENTS

##### 4.1 Materials and Parts Traceability

Material and parts traceability shall be required on:

- ° Electrical Components. Identification of electrical and electronic parts for qualification and flight articles such as semiconductors, relays, transformers, connectors, etc., shall be traceable "to the manufacturer, date of manufacture, and the manufacture's lot control number."
- ° Raw Material. Traceability is required to the physical and chemical analysis. Non-metal raw material requires a "Certificate of Conformance" to the applicable specifications; e.g., glass, plastic, etc.
- ° Special Materials or Products. Traceability is required to the physical and chemical analysis of such special materials as titanium, columbium, or niobium. When such materials are used in the fabrication or flight articles of any description, traceability is required similar to that of electrical and electronic manufacture described above.
- ° The supplier's material control systems must provide a positive method for tracing the above material from the highest TRW Systems Group procured level of each assembly down to the individual raw material or component lots. Records must be available at the supplier's facility for TRW Systems Group review upon request.

Exemptions from Material and Parts Traceability:

- ° Material and products which are utilized in non-critical applications and are not otherwise required to be identified for traceability as described above, may be considered exempt from this requirements.
- ° A list of such items is shown below for reference. If in the opinion of a supplier, other items he supplies also fall within this category, he may request approval by supplying an additional list with his reasons through the cognizant TRW Systems Group Materiel Division representative.

Items (General Sample List) Exempt from Traceability

AN Fittings	*Nuts
AND Fittings	Packing Material
*Bolts	Pins
Buss Wire	Rivets
Clamps	*Screws
Clips	Shackles
Eyelets	Shims
Identification Plates	Solder
Insulation Tubing	Solder Fluxes
Lacing Cord	Spacers
MS Fittings	Studs
Mylar (as used for	Tape
welded module	Washers
"end cards")	

\*NOTE: All titanium bolts, nuts and screws will be traceable to manufacture, date of manufacture, and manufacturer lot code.

Exhibit 1-4

PAR 700-55  
13 FEBRUARY 1970

PROCUREMENT

PERFORMANCE ASSURANCE REQUIREMENTS

QUALITY, RELIABILITY AND MAINTAINABILITY PROVISIONS

PROJECT ERTS SUBCONTRACTORS

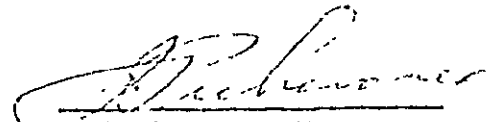
FOR

GDHS EQUIPMENT

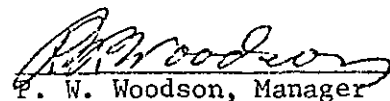
Approved:



J. K. Holau, ERTS  
Project Quality Manager



J. Pickavance, Manager  
Space Vehicles Product Assurance



F. W. Woodson, Manager  
Performance Assurance, ERTS Project

TRW  
SYSTEMS GROUP

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PAR- 700-55

REVISION STATUS SHEET

Revision	Date	Change	Signature

PERFORMANCE ASSURANCE REQUIREMENTS  
PROJECT ERTS GDHS EQUIPMENT

1. PURPOSE

1.1

To define the detailed TRW Systems Group Performance Assurance requirements to subcontractors of Ground Data Handling System (GDHS) equipment for the ERTS (Earth Resources Technology Satellite).

1.2

To provide subcontractors with the guidelines necessary to meet the basic quality, reliability and maintainability requirements of the subcontract for eventual equipment acceptance by the Government.

2. GENERAL REQUIREMENTS

2.1

The subcontractor shall provide and maintain an inspection system meeting all the requirements of NASA Quality Publication NPC 200-3, "Inspection System Provisions for Suppliers of Space Material, Parts, Components and Services", dated April 1962, except as amended herein.

2.2

In addition to the requirements of this document, PAR 700-55, the subcontractor shall meet the supplemental quality, reliability and maintainability requirements to this document and the requirements of the supplemental clauses of TRW Systems Form 1991, "Supplier Quality Attachment I to SQI 3.0.3", when these clauses are specified on the purchase order/subcontracts.

2.3

When the subcontractor determines that certain requirements of this document are deemed not pertinent to his subcontract, request for clarification and/or deletion should be made to TRW Systems Group. Mil-spec and off-the-shelf (existing catalog) items are exempt from the NPC 200-3 requirements.

### 3. AMENDMENTS TO NPC 200-3

#### 3.1 Preparation and Submission of Suppliers' Inspection Plan NPC 200-3, Section 2.2

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The subcontractor shall submit three (3) copies of a written inspection plan to TRW Systems Group for approval within thirty (30) days after purchase order award. The format of the subcontractors' plan shall be in substantial accordance with each section heading of NPC 200-3 and the additional requirements of this document.

#### 3.2 Drawing and Change Control (NPC 200-3, Section 2.4)

##### 3.2.1 General

The subcontractor must maintain a system for implementing, recording and verifying changes in product configuration at specified change effectivity points. When design is the subcontractor's responsibility, but design changes require TRW approval prior to incorporation and/or production, Class I changes shall not be made in design or manufacture without the written approval of TRW.

##### 3.2.2 Design Review(s)

The subcontractor shall schedule and conduct formal design reviews in accordance with the statement of work. For each design review, cognizant TRW Systems personnel shall be notified in advance and will participate as members of the reviewing group. The design shall be reviewed for both adequacy of conceptual approach and feasibility of simplifying design concepts and shall consider quality, reliability and maintainability requirements. The reviews shall cover materials, processes, electrical, mechanical, thermal and GDHS specification requirements, flow and logic diagrams, programming, test checkout, and compatibility interfaces. Existing failure histories shall be presented and reviewed for adequacy of the corrective actions to eliminate repetition of known failures. Special design reviews may be scheduled by TRW Systems or the subcontractor as the need arises.

3.2.2.1 Design Review Data Required. Data requirements for the design reviews are as shown in the Statement of Work. The data shall form the basis for reviewing the design and must be submitted at the customer's facility, a minimum of ten (10) working days prior to the date of the design review.

3.2.2.2 Design Review Minutes. Complete minutes of each design review meeting giving details of discussion, conclusions reached, actions items assigned, dates of completion, attendance, and similar pertinent information shall be submitted to TRW Systems in a design review report. Design review action items which are not completed shall be reported through the periodic progress report. The subcontractor shall issue a subsequent design review completion report when the action items generated at each design review have been completed.

### 3.3 Government Source Inspection (NPC 200-3, Section 3.2)

When the purchase order specifies Government Source Inspection required, all work is subject to inspection and test monitoring by the Government representative. Notification should be in advance of the inspection and/or test operation at a time mutually agreed.

Delegation of Material Review Board authority to the Government representative that normally services the subcontractor's plant though not normally granted (para. 3.6), shall be at the discretion of the responsible Government agency for this contract.

### 3.4 Control of Materials (NPC 200-3, Section 3.5)

Raw materials, materials, and products shall be inspected to determine conformance to applicable specifications and drawings and acceptability for use on deliverable equipment. Where appropriate, the subcontractor may use GSFC Preferred Parts List PPL-10 as a guide for electronic part selection and control.

### 3.5 Inspections and Test (NPC 200-3, Section 3.6)

The inspections and test performed shall include in addition to the NPC 200-3 requirements, the qualification and acceptance testing of software, the integration of the hardware and software at the site using

engineered stimuli to simulate operating conditions, and the performance of the system during observatory orbital operations.

### 3.6 NONCONFORMING ARTICLES (NPC 200-3, SECTION 3.8)

TRW Systems Group will normally not delegate material review authority to its subcontractors, who may perform preliminary reviews and make dispositions in accordance with the provisions of Section 3.8. If a major subcontractor to TRW has design cognizance, he may request authority to establish a formal Material Review Board for purposes of making dispositions on materials or products on which variations exist. Deviations can only be dispositioned by NASA by means of a request for contractual waiver. The granting of variation materials review authority by TRW is contingent upon concurrence by TRW's customer and the cognizant Government inspection agency. For purpose of this document, variation and deviation are defined as follows:

- "Variation": Any nonconformance to drawing or specification requirements which, in the opinion of TRW Systems Group Quality Assurance does not adversely affect safety, interchangeability, service life, reliability or performance.
- "Deviation": Any nonconformance to drawing or specification requirements which, in the opinion of TRW Systems Group Quality Assurance does adversely affect safety, interchangeability, service life, reliability, performance, or the basic requirements of the contract.

If a major subcontractor wishes to request variation material review authority from TRW Systems Group, he must submit the following to TRW Systems Group Quality Assurance via TRW Systems Group Materiel. Complete documentation of the proposed Material Review Board organization and the policy under which the board proposes to operate. This documentation must include:

- Organization chart(s) showing the line authority of all proposed engineering and Quality personnel involved.
- Complete resumes of proposed personnel, showing their backgrounds, experience, education, etc.
- Copies of proposed detailed operating procedures.

- Complete description of the cause investigation and corrective action system the subcontractor proposes to use to prevent the recurrence of all variations that the proposed board will review disposition.

When a subcontractor is approved to conduct a formal material review on variation, TRW Systems Group reserves the right to reject the decision of the subcontractor's Material Review Board; additionally, TRW reserves the right to reject materials or products covered by such decisions after delivery at a TRW Systems Group facility, or the installation site. The subcontractor's cognizant Government Quality Assurance representative must approve all decisions made by the other two members of the subcontractor's Material Review Board. The subcontractor's Material Review Board can make the following decisions:

- Scrap: Any one (1) member of the board may make a scrap decision without the concurrence of the other two (2) members.
- Reject: (Return to Vendor): Any one (1) member of the board may make a reject decision without the concurrence of the other members.
- Rework to Specification: If the nature of proposed rework is minor, and does not require engineering action, the decision to rework may be made by the quality member of the board. Major rework requires engineering members concurrence.
- Rework Beyond Specification: This decision requires concurrence of all members of the board. At the time this decision is made, it must be decided whether the extent beyond specification constitutes a variation or a deviation; this decision requires the concurrence of all members of the board, as a deviation cannot be accepted.
- Use As Is: This decision requires concurrence of all members of the board. NOTE: Deviations cannot be accepted by Material Review Board.

### 3.7 CONTROL OF INSPECTION MEASURING AND TEST EQUIPMENT (NPC 200-3, SECTION 3.9)

The calibration of measuring and test equipment must be in conformity with MIL-C-45662A.

### 3.8 Records of Inspections and Tests (NPC 200-3, Section 3.13)

An end-item inspection and test report shall be prepared and transmitted with the subcontract end-item and shall include the following:

- End-item configuration list
- End-item nonconformance record
- Copy of end-item systems acceptance test reports on procedures which include variables test data and results.
- List of critical and time/temperature sensitive articles
- Operating time/cycle record of system and subsystem, where applicable
- Final assembly build-up and test procedure, including end-item test article replacements.

Records of all inspections and tests shall be made available to TRW Systems Group for review when requested.

## 4. ADDITIONAL REQUIREMENTS

### 4.1 TRW Systems Group Source Surveillance

Periodic audits may be made by TRW Systems Group Quality Assurance in coordination with Materiel during the life of the purchase order to determine compliance with this document and the extent to which the specified procedures are being followed by the subcontractor. Upon completion of the audit, the subcontractor will be notified in writing of those areas requiring correction. The subcontractor will be given an appropriate period of time within contractual limits to correct deficiencies.

TRW Systems Group Quality Assurance reserves the right to interpret the extent to which this document applies on supplies and services for each subcontract.

TRW Systems Group may assign resident or itinerant Engineering/Quality Assurance personnel to the subcontractor's facility during performance of the subcontract. The subcontractor must, during regular business hours, or at such other time as may be necessary, permit such

personnel access to his facilities for determination of compliance with this document and must furnish without cost to TRW Systems Group such facilities and services which may reasonably be required in support thereof.

#### 4.2 Indoctrination and Training

The subcontractor shall institute a training program for personnel, as necessary, to operate the deliverable, system to assure that their skills and knowledge keep pace with the advancing technology, and to minimize or eliminate the errors due to the human element. The training program shall be subject to TRW Systems audit.

#### 4.3 Failure Data Collection and Corrective Action

The subcontractor shall implement a failure reporting and corrective action system in accordance with the requirements listed below. A failure is defined as any inability of a part, subassembly, component or function to perform in accordance with product specification requirements.

##### 4.3.1 Failure Reporting and Corrective Action System

The subcontractor shall implement a formal and controlled system for the reporting, analysis, corrective action, and data feedback of all failures and malfunctions which occur during system integration and operational tests performed after equipment installation on-site. This system shall emphasize reporting, analysis and corrective action of all failures and malfunctions, regardless of their apparent magnitude. The subcontractor shall accomplish timely and appropriate action to prevent recurrence of these failures and malfunctions. The subcontractor's reliability organization shall review the procedures and monitor the implementation of this system.

##### 4.3.2 Failure Notification

The subcontractor shall report failures to TRW Systems no later than 48 hours after the failure event. The TWX shall be addressed to the cognizant TRW Systems Contracts Administrator.

#### 4.3.3 Failure Reporting

The subcontractor shall document all failures as defined in 4.3 providing information to adequately describe the failed item, the operation in progress, the conditions of failure, the symptoms of failure; the action taken at the time of failure and the opinions of those who observed the failure as to the probable causes and possible methods of corrective action. The failure report shall be transmitted automatically to the subcontractor's internal organizational elements affected and shall be filed for ready reference in a central location. A copy of the failure report shall be sent to TRW Systems no later than 7 days after the occurrence of the failure.

#### 4.3.4 Failure Analysis

The subcontractor shall analyze all failures to determine the cause of each failure. The failure analysis format shall reference the failure report and include a brief description of the actual failure, the methods of analysis and a technical description of the cause or causes. In each case, the analysis shall be performed by or concurred with the organization responsible for the implementation of corrective action.

#### 4.4 Maintainability Analysis

The subcontractor shall perform a maintainability analysis of the GDHS equipment and define in detail the activities, support documentation, personnel and equipment required to perform each corrective and preventative maintenance task associated with the servicing of the GDHS hardware. The significant failure modes of each hardware end-item shall be identified together with an estimate of the frequency (failure rate) that each may be expected to experience in an operational environment, the unwanted effects that can occur in the event of each subassembly failure mode, and the method of failure recognition and fault isolation utilizing equipment monitors and controls. In addition, for each such failure mode, a maintenance concept shall be described which shall include the type of personnel and equipment which are necessary to effect a repair or replacement in a timely manner together with an estimate of the average length of time (Mean-Time-To-Repair, MTTR)

needed to complete the repair action and return the item to operational status. This includes considerations for emergency corrective measures.

The latter time shall also include specific recommendations for equipment checkout and status verification required to assure that the repair is effective. Recommendations for each hardware end-item shall also be made in the areas of scheduled maintenance and sparing levels. The rationale for determining the frequency and duration of scheduled maintenance periods shall be provided; similar data concerning recommended spares packages or kits shall also be provided, the objective being the identification of a spares package which will reduce the likelihood of running out of spares in a cost-effective manner. These analysis tasks will utilize data gathered on previous applications of similar equipments to the maximum possible extent. The above analysis task shall be performed and presented for each design review and updated as necessary throughout the program. Submittal of the final analysis report will be made at the conclusion of the 30 day operational performance period for the GDHS.

#### 4.4.1 Operating Time Logs

Operating time logs will be maintained for each unit during periods for which failure reporting is required to evaluate the accuracy of previously derived analytic projections. Elapsed time meters, sign-in, sign-out sheets, or other workable procedures shall be employed to ensure that the starts, stops and operational times for the hardware items are accurately kept. The duration of time required to complete any maintenance action shall be noted together with some assessment as to whether the repair effected was in accordance with the method projected in the maintainability analysis. Unusual conditions which are felt to be nontypical shall be identified.

## EXHIBIT 1-5

### PACE SYSTEM DESCRIPTION

#### INTRODUCTION

PACE is an automated software product assurance checkout and evaluation system.

PACE has been designed to provide software managers and procurers significant support in determining and controlling computer program quality. PACE is useful also to computer programmers during development and debugging of computer programs. The individual features or capabilities of PACE were chosen on the basis of their ability to provide useability either as a separate component or as elements in the integrated PACE system.

#### PACE CAPABILITIES

The PACE system is oriented toward the evaluation of the performance of computer program code. The system assists verification of the extent to which a subject computer program satisfies specified requirements. In doing this, three major capabilities have been developed:

- Identification of testable program segments (logic paths and computational blocks)
- Automatic generation of test data
- Quantitative analysis of test performance and test comprehensiveness.

By identifying the test segments that should be verified, generating test data, providing a test driver, and evaluating test results, a total software quality assurance systems approach has been taken.

#### PACE SYSTEM WALKTHROUGH

There are four major user phases in the PACE system (see Figure 1, PACE System Flow). These are:

- Test segmentation
- Test data base generation

- Test execution and evaluation
- Test comprehensiveness analysis

## PROGRAM TEST SEGMENTATION

The first task in the utilization of PACE is to identify in the program design specification the primary or system outputs of interest and those computational blocks which result in intermediate outputs of interest. This segmentation is the usual practice of dividing up the program into pieces which can be worked with ease. The PACE system is designed to assist the programmer in this effort. Both of these outputs are identified in a test specification document. In addition, during program coding, computational block identifications are defined within the code. The programmer further specifies the inputs to a block by name with data values and the expected output names and values for each block. This information is collected by a computer program, AUDIT, in the PACE system and placed in a test data catalog. The AUDIT program can perform a code scan and identify and classify input and output data names for each block if required. Test data initial values are automatically provided (nominal value of 1) if none are specified by the programmer.

The output data names of the subject program or system are specified to another PACE computer program, COVER. Inputs may also be specified. This program determines all computer program logic paths which result in generation of the required output data. These paths are identified and comments about the data they require and the processing they perform are developed from the program code so that the programmer can indicate a logic path priority if he desires. This information is also stored in the test data catalog.

## TEST DATA BASE GENERATION

A test data catalog is generated containing information about all of the blocks and paths in the test data base. The user can update this information directly, if desired, or add special test cases he has devised. This test data base serves as a test case repository for the evaluation of the program quality. In the PACE system, this test data base maintenance function is performed by a program called CATALOG.

A-42a

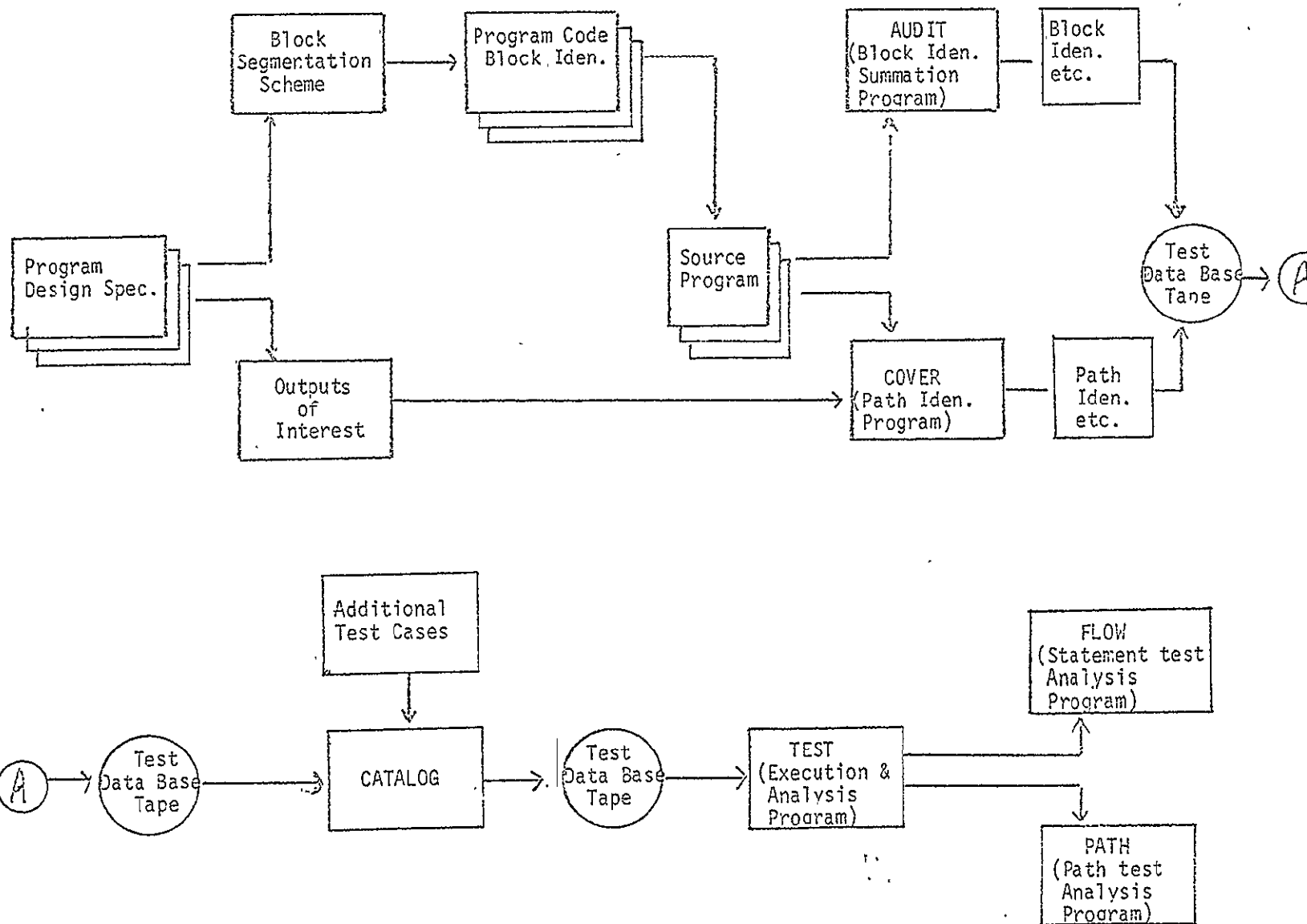


Figure 1. PACE System Flow

## TEST EXECUTION AND EVALUATION

This phase of the PACE system operation provides a driver for the execution of the subject program with inputs from the test catalog or test inputs directly inserted by a user. The subject program, prior to execution, is instrumented with recording traps at all program control points. The test driver executes the subject program and records test results. Trapping provides both selection of intermediate results and accounting information for subsequent analysis to determine what and how much was tested. In addition, in this phase of the PACE system, computer code is examined for potential coding construction errors such as data references that are out of the program environment or closed out code which will not be executed. In addition, a test evaluation is made through comparison of expected and actual outputs. Discrepancies are noted based on specific tolerances, a summary analysis is prepared and an extrapolation of computer program quality is made. This phase of PACE is performed by a program called TEST. One example of the extrapolation would be the numerical ratio of the out-of-tolerance comparisons to total comparisons performed.

## TEST COMPREHENSIVENESS ANALYSIS

The last phase of the PACE system is an analysis of the extent of the testing performed for both computational blocks and program paths. One PACE capability is achieved by a program called FLOW. FLOW generates three outputs of interest. The first is an indication of the number of statements exercised versus the total number of executable statements. The result is a quantitative value for the percent of statements executed in a single test or a series of tests and, as such, is a simple measure of the comprehensiveness of the test plan. If a test plan, for example, exercises less than 50 percent of the total program instructions, the plan is probably in need of redesign or the program is in error. The second output indicates how many times each statement was executed, if at all. Statements or computational blocks not exercised by the test plan require evaluation for appropriate corrective measures. The third output is a higher level language trace which can be used for

post-mortem analysis of test path execution. The trace output is most valuable during the program debugging phase and as a means for determining the reason for a computational block not being exercised.

A second major analysis tool is PATH. PATH generates a quantitative analysis of the data distribution for the paths exercised and an analysis of the paths exercised versus the total number of legal paths through the program system. This information can also be organized by path priority. The data distribution analysis measures the actual data encountered by the program against the functionally independent inputs and outputs for which the program is expected to perform. Assuming that a summary of program performance is maintained, an extrapolation of program quality is a simple matter.

#### SUMMARY

Program test segment identification, test case maintenance, test execution, and analysis provide a significant set of capabilities which aid in the important tasks of program debugging, verification, and validation. PACE capabilities have been organized so that they force good quality assurance management techniques throughout the program production cycle (see Figure 2). The PACE system capabilities are summarized below. They have been organized by components so that they are separately useable (see Figure 3).

The PACE system provides the user with the capability to:

- 1) Under user control, specify blocks and block test data within the program
- 2) Automatically identify erroneous coding structures
- 3) Automatically identify program (or subprogram) "logic paths" and input/output data for the "path"
- 4) Under PACE system control, maintain and edit a test catalog: test cases, test data ranges, and test data points
- 5) Under PACE system control, operate tests from the test catalog and analyze results. The analysis will identify illegal (or probably illegal) statements and data references.

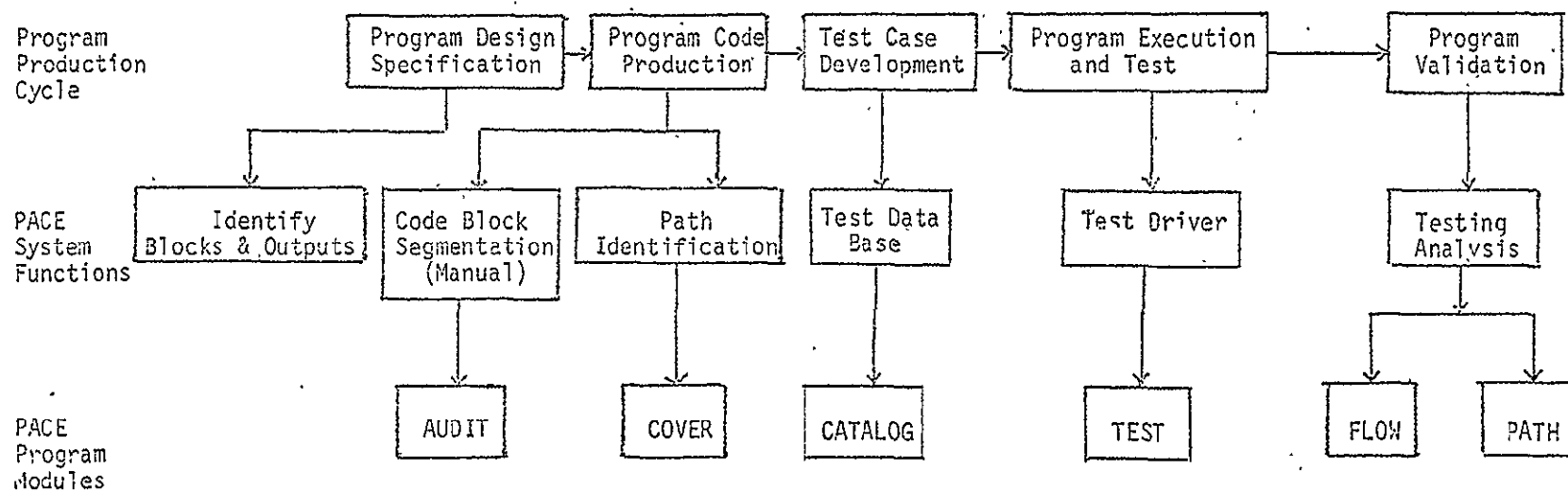


Figure 2. Program Production Cycle and PACE System

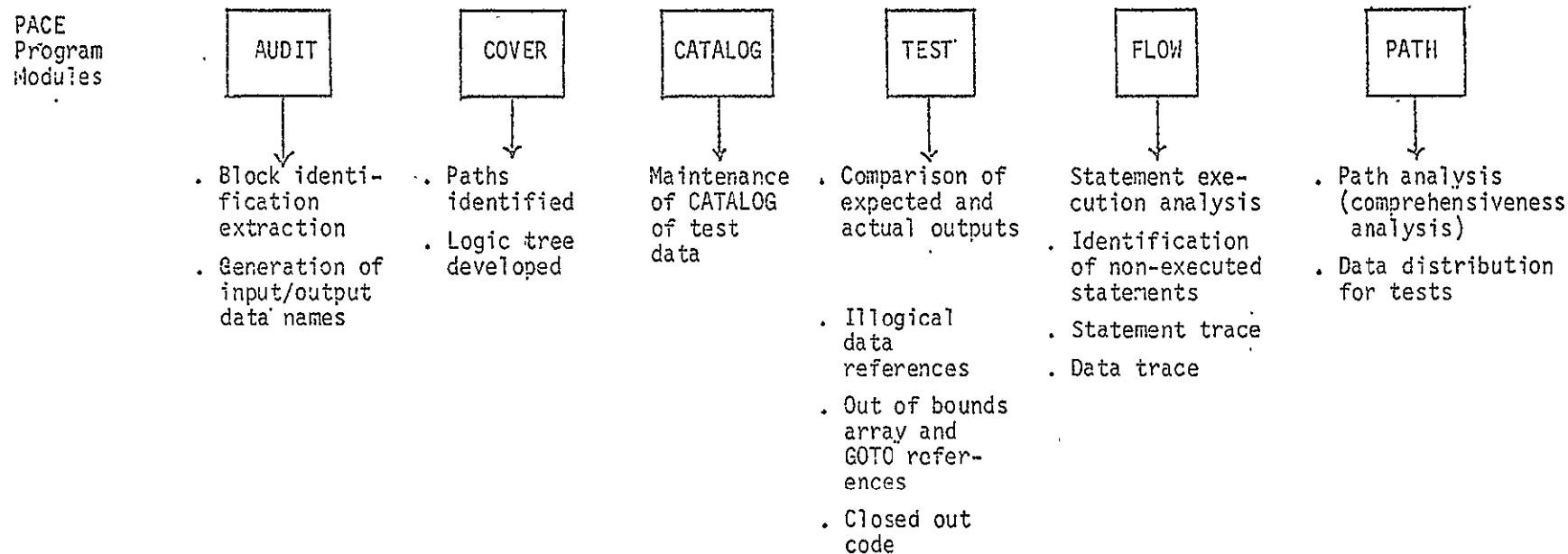


Figure 3. PACE System Modules and Capabilities

- 6) Automatically produce a statement usage analysis. A statement trace and data trace is also provided.
- 7) Automatically produce a summary of the paths exercised (and not exercised) with an analysis of the distribution of the test data used.

## FLOW DEMONSTRATION AND DESCRIPTION

The following pages provide a brief description of the FLOW program and the outputs from a demonstration run of the FLOW program. FLOW is one component of the software PACE system.

## DESCRIPTION OF FLOW

FLOW is a computer program that provides insight into the quality of FORTRAN computer programs by analyzing the extensiveness of the testing. As such, it is a tool for automated software quality assurance.

The objectives of the FLOW system are to provide performance assurance and development management quantitative data on computer program testing effectiveness and debugging information for programmers. The FLOW system will provide quantitative data regarding the comprehensiveness of testing used to determine compliance with performance requirements.

FLOW detects and records each program control point executed by the program under analysis, then prints this information and shows the user the actual sequence of statements executed.

## APPLICATION

FLOW program analysis assists the user in:

- 1) Determining program test completeness by indicating the subject program's statement use. FLOW identifies areas where testing was heaviest, areas where additional testing might be required, and areas where no testing occurred.
- 2) Detecting when and where change in the program causes unpredicted change in program flow. Here, FLOW can be especially valuable for validation of flow logic following incorporation of approved program changes.
- 3) Debugging and becoming familiar with program operation.

## OPERATION

FLOW operates in a three step process. To the user, this operation is transparent. The FLOW program operating steps are as follows:

- 1) FLOW analyzes the FORTRAN source language tape, assigns a sequential statement number (pseudo-number) to each executable statement, inserts traps at each program control point, and appends the source language FLOW recording routine to the FORTRAN source language tape.
- 2) The modified FORTRAN program is then compiled and executed. During execution of the modified FORTRAN program, a record is made on a recording tape each time a control point is encountered.
- 3) Following execution of the FORTRAN program, FLOW processes the recording tape and annotates a copy of the original FORTRAN source language program listing by placing a number beside each statement to indicate the number of times the statement was executed. A listing of pseudo-number pairs is generated which comprises the Trace and depicts the program flow. A quantitative analysis is made of the number of statements exercised versus the total number of operable statements.

## INPUTS AND ENVIRONMENT

The environmental software required consists of the compiler and the operating system. The following must be provided as input to FLOW:

- 1) Option control card
- 2) FORTRAN program, in source language form
- 3) Data submitted
- 4) Program and test ID
- 5) Name of person responsible for program test
- 6) Test inputs.

## OUTPUTS

Three outputs are possible; Trace and Map outputs are optional.

The Trace output is a summary list of pseudo-statement number pairs. Pseudo-numbers are assigned by FLOW. The left number of a pair is that of the statement branched to (entry), and the right is of the last statement executed (exit). Each pair thus denotes a block of contiguous FORTRAN statements operated.

The Map output is a listing of the annotated source program and is identical to the source program listing except that: a sequential pseudo-number appears to the right of each executable FORTRAN statement, and a number appears to the immediate right of each pseudo-number, indicating how many times the statement was executed; zero indicates that it was not executed. For a logical IF (one-branch IF) statement, the right half of the statement is assigned a separate pseudo-number, and an additional number appears to the right, indicating the number of times the right half of the IF statement was executed.

The Statement-Use-Analysis output is a summary count of the statements executed and a total of the statements which could have been executed. A test effectiveness ratio is generated by dividing the number of statements executed by the total number possible.

## DESCRIPTION OF DEMONSTRATION OUTPUTS

On the attached pages are the outputs and inputs from a demonstration run of FLOW. The first three pages describe outputs.

First is the Statement-Use-Analysis Summary. This output indicates that 19 of a possible 24 statements were executed of 79 percent of the total program. This information is used as a quantitative analysis of the comprehensiveness of the testing applied.

Trace output is furnished next. This output indicates the order of the FORTRAN statements which were exercised. For instance, the Trace output indicates statements "1" through "5" were executed. Statement "5" is the last half of the one-branch IF statement. The statement numbers are generated by the FLOW program system. This output

is used for possible program debugging. Trace output is formatted in a manner which facilitates an analysis of computer program modularity and may be used to improve the overall logical structure.

The Map output indicates the frequency with which each statement was exercised. For instance, statement "19" was operated three times. Statement "11" was not operated. This output tells a user where testing is possibly deficient and also if a test is optimally designed to exercise the portions of the program of interest. This output is especially helpful to the user who wishes to optimize program code to reduce execution time and does so in program segments receiving heaviest usage.

Also furnished is a listing of the program outputs from program operation based on inputs listed on the same page.

**TRW** SYSTEMS

STATEMENT USE ANALYSIS SUMMARY

OF THE 24 EXECUTABLE STATEMENTS, 19 WERE EXECUTED BY THE TEST CASE

THE TEST EFFECTIVENESS RATIO = .79

**TRW** SYSTEMS

TRACE  
-----

PSEUDO NO. OF  
ENTRY EXIT

1	5
6	7
18	18
22	24
19	19
3	4
6	7
8	9
23	24
10	10
19	19
3	5
6	7
15	15
17	17
19	21

```
PROGRAM TEST(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
INTEGER TBL1(3),TBL2(3),TBL3(3),TBL4(3),TBL5(3)
```

```
READ(5,1)TBL1,TBL2,TBL3
```

PN= 1 FREQ= 1

```
FORMAT(3I10)
```

```
BEGIN COMPUTATION FOR TBL5 ETC.
```

```
DO 3 K=1,3
```

PN= 2 FREQ= 1

```
TBL5(K)=1
```

PN= 3 FREQ= 3

```
IF(TBL1(K).NOT.0)TBL5(K)=0
```

PN= 4 FREQ= 3, 2

```
TBL4(K)=TBL2(K)+TBL3(K)
```

PN= 6 FREQ= 3

```
IF(TBL4(K))6,2,8
```

PN= 7 FREQ= 3

```
TBL4(K)=-TBL4(K)
```

PN= 8 FREQ= 1

```
CALL DOUBLE(K,TBL4)
```

PN= 9 FREQ= 1

```
GO TO 3
```

PN= 10 FREQ= 1

```
TBL2(K)=1
```

PN= 11 FREQ= 0

```
TBL3(K)=1
```

PN= 12 FREQ= 0

```
TBL4(K)=1
```

PN= 13 FREQ= 0

```
GO TO 3
```

PN= 14 FREQ= 0

```
IF(TBL2(K).EQ.TBL3(K))GO TO 9
```

PN= 15 FREQ= 1, 0

```
GO TO 3
```

PN= 17 FREQ= 1

```
CALL QUAD(K,TBL4)
```

PN= 18 FREQ= 1

```
TBL4 WAS DOUBLED TWICE
```

```
CONTINUE
```

PN= 19 FREQ= 3

```
WRITE(6,11)TBL1,TBL2,TBL3,TBL4,TBL5
```

PN= 20 FREQ= 1

```
FORMAT(1H1/15X,19HPROGRAM TEST INPUTS///10X,5HTBL1=3I10//
```

```
110X,5HTBL2=3I10//10X,5HTBL3=3I10/////15X,19HPROGRAM TEST OUTPUTS//
```

```
210X,5HTBL4=3I10//10X,5HTBL5=3I10)
```

```
STOP
```

PN= 21 FREQ= 1

```
END
```

```
SUBROUTINE QUAD(I,T)
```

```
INTEGER T(I)
```

PN= 22 FREQ= 1

```
T(I)=T(I)+T(I)
```

```
ENTRY DOUBLE
```

```
T(I)=T(I)+T(I)
```

PN= 23 FREQ= 2

```
RETURN
```

PN= 24 FREQ= 2

```
END
```

**TRW** SYSTEMS

PROGRAM TEST INPUTS

TBL1=	20	0	25
TBL2=	30	-5	50
TBL3=	40	-10	-50

PROGRAM TEST OUTPUT

TBL4=	280	30	0
TBL5=	0	1	0

Exhibit 1-6

PROCUREMENT

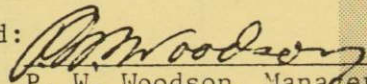
PERFORMANCE ASSURANCE REQUIREMENTS

PROJECT ERTS SUBCONTRACTORS

FOR

GDHS SOFTWARE

TRW  
SYSTEMS GROUP

Approved:   
P. W. Woodson, Manager  
Performance Assurance

REVISION STATUS SHEET

Revision	Date	Change	Signature

## 1.0 PURPOSE

- 1.1 To define the TRW Systems Group Performance Assurance requirements to subcontractors of Ground Data Handling System (GDHS) software for the ERTS (Earth Resources Technology Satellite) Project.
- 1.2 To provide subcontractors with software guidelines necessary to meet the basic requirements for Performance Assurance management, testing, verification and reporting activities of the subcontract.

## 2.0 GENERAL REQUIREMENTS

The subcontractor shall provide and maintain a quality assurance plan to meet the requirements of the subcontract and be compatible with the equipment provided in accordance with PAR 700-55.

An initial version of the plan shall be delivered to TRW Systems at the time of Intermediate Software Review (ISR) - which occurs upon completion of the initial design approach.

## 3.0 CONFIGURATION MANAGEMENT

Configuration Management requirements for software shall be in accordance with TRW Systems Document PAR 700-56 (formally EBC-CMR-001).

## 4.0 SOFTWARE DEVELOPMENT AND TEST PLAN

### 4.1 Software Program Development

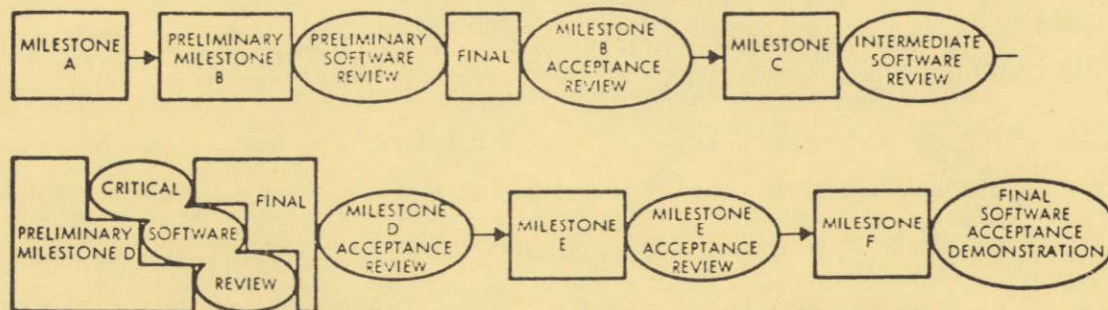
Software packages which are developed for ERTS shall be designed, tested, and validated in accordance with the milestone requirements as noted in Figure 1 and as defined below:

Milestone A Automatic Data Processing Software (ADPS) Computer Design Criteria (TRW)

Milestone B Implementation Concepts and Preliminary Design Specification (computer program development contractor)

Milestone C ADPS Computer Program Interface Specification (software subsystem integration contractor)

Milestone D ADPS Detailed Specification (computer program developer)



PURPOSE		EVENT	CONTENT
REQUIREMENTS	A	MILESTONE A	SOFTWARE FUNCTIONAL AND OPERATIONAL REQUIREMENTS
SPECIFICATIONS AND PRELIMINARY DESIGN	B	PRELIMINARY MILESTONE B	IDENTIFICATION AND SPECIFICATION SOFTWARE FUNCTIONS, IDENTIFICATION AND DESIGN OF SOFTWARE ROUTINES
		PRELIMINARY SOFTWARE REVIEW	NASA REVIEW OF MILESTONE B
		MILESTONE B	CONTRACTOR UPDATE OF MILESTONE B
		MILESTONE B ACCEPTANCE REVIEW	ACCEPTANCE REVIEW BY NASA BEFORE DETAILED DESIGNED BEGINS
DETAILED INTERFACE SPECIFICATIONS	C	MILESTONE C	DETAILED DEFINITION AND DESIGN OF ALL SOFTWARE INTERFACES. DATA DEFINITION SPECIFICATION WHICH DESCRIBES THE DATA BASE AND COMPUTING HARDWARE INTERFACES, COMMAND DEFINITION SPECIFICATION, AND OBSERVATORY-SOFTWARE CONSTRAINT SPECIFICATION WHICH DESCRIBE THE MAJOR EXTERNAL CONSTRAINTS
		INTERMEDIATE SOFTWARE REVIEW	NASA REVIEW OF MILESTONE C
FINAL DESIGN AND TEST SPECIFICATIONS	D	PRELIMINARY MILESTONE D	DETAILED DESCRIPTION OF WHAT IS TO BE PROGRAMMED, ACCEPTANCE AND TEST SPECIFICATION, OPERATIONS MANUAL, AND TRAINING PLAN
		CRITICAL SOFTWARE REVIEW	SEGMENTED REVIEWS BY NASA OF MILESTONE D, PERMITTING EARLY PROVISIONAL RELEASE FOR PROGRAMMING TO BEGIN
		MILESTONE D	CONTRACTOR UPDATE OF MILESTONE D
		MILESTONE D ACCEPTANCE REVIEW	FINAL ACCEPTANCE REVIEW BY NASA BEFORE PROGRAMMING BEGINS
COMPUTER PROGRAM, TEST RESULTS	E	MILESTONE E	THE COMPUTER PROGRAM, UPDATED AS-BUILT MILESTONE D, VALIDATED TEST RESULTS, TRAINING DOCUMENTATION
		MILESTONE E ACCEPTANCE REVIEW	ACCEPTANCE REVIEW BY NASA BEFORE SYSTEM LEVEL VALIDATION TESTING BEGINS
SYSTEM INTEGRATION	F	MILESTONE F	PROGRAMS ARE EXERCISED IN THE COMPLETE HARDWARE-SOFTWARE ENVIRONMENT. NO NEW DOCUMENTS, BUT ALL DOCUMENTS ARE UPDATED TO REFLECT CHANGES
		FINAL SOFTWARE ACCEPTANCE DEMONSTRATION	NASA REVIEW OF MILESTONE F CULMINATING IN ACCEPTANCE OF THE SOFTWARE PRODUCTS

Figure 1. Milestones for the Development of GDHS Software

Milestone E ADPS Computer Program Products and Documentation  
(computer program developer)

Milestone F ADPC Final Software Acceptance Demonstration  
(software subsystem integrator)

- 4.2 Test requirements will be established by the use of the contract statement of work and Milestones B and D specifications.

The completion and results of all tests must be reported to TRW as follows:

- ° Preliminary qualification testing at Milestone D
- ° Final qualification testing prior to acceptance of the CI.
- ° All testing activities, including milestone completions

- 4.3 NASA/GSFC and TRW Systems Group ERTS Project Office shall be represented at all specified design reviews and shall approve all specifications.

## 5.0 SOFTWARE PROBLEM REPORTING AND CORRECTIVE ACTION

The subcontractor shall implement a software problem reporting and corrective action system in accordance with the requirements listed below. A software problem is defined as:

- ° A function having no output, incomplete output, or the output values exceed established deviations from the expected value.
- ° A function failing to interface (link).
- ° A function execution time exceeding timing constraints.

- 5.1 Software problem reporting will be initiated on the functional level during first use or sign-off, whichever comes first.

- 5.2 The levels of software are defined as follows:

- ° Routine - the smallest collection of serial code which has a recognizable input and output, and performs one or more tasks for the module.
- ° Module - a series of tasks with a given function.
- ° Function - a group of computer programs working together to perform a major task as defined in the function-level specification.

- ° Computer Program - an ordered collection of instructions, tables and constants which constitute a single software entity designed to perform a given task.
- ° Automatic Data Processing Software - the collection of all computer programs utilized in the automatic data processing equipment.